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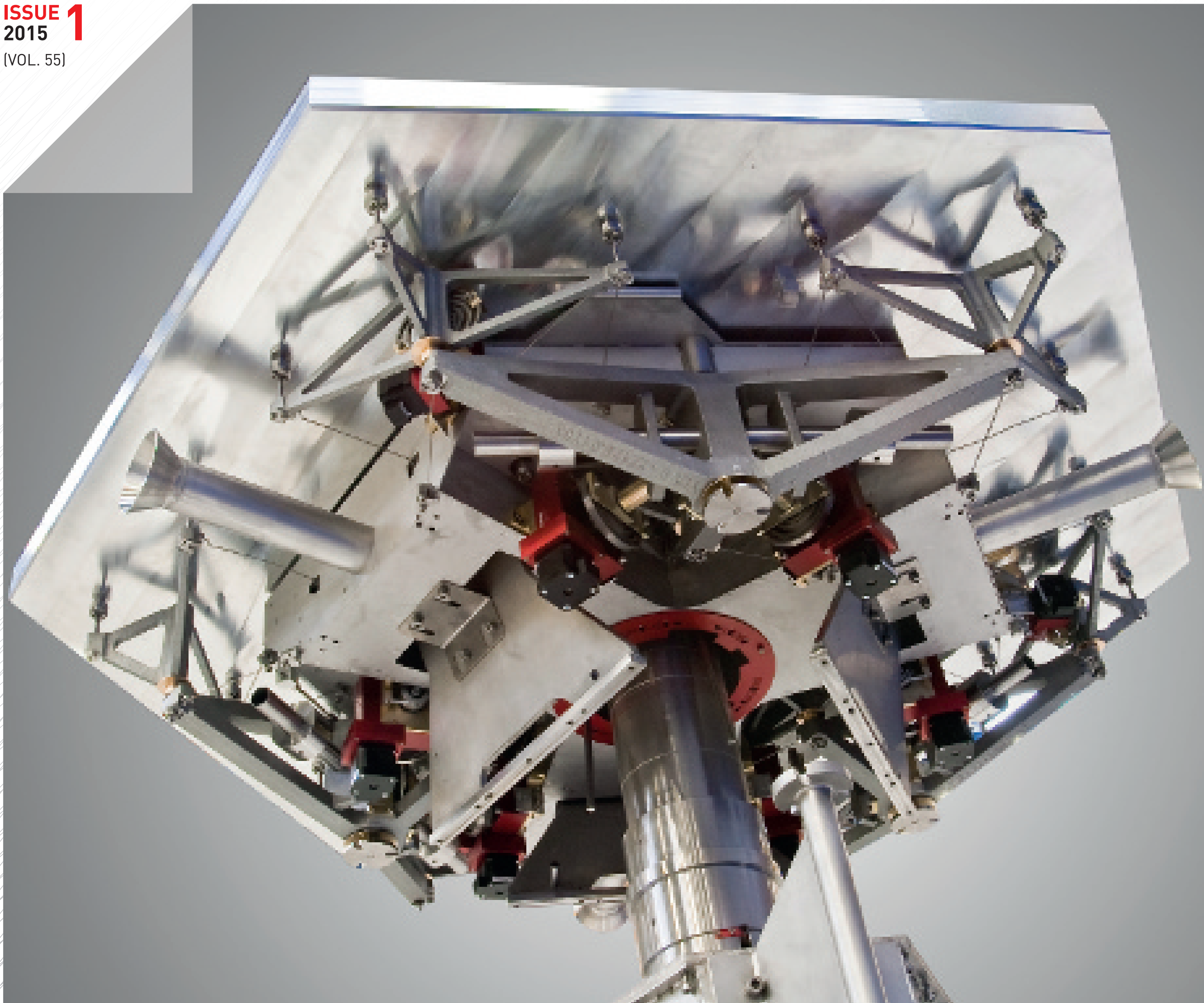
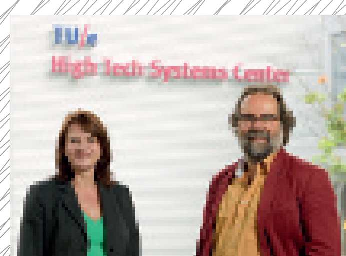


- **R2R** FLEXIBLE ELECTRONICS
- **HIGH TECH SYSTEMS CENTER**
- WHAT'S **ULTRA PRECISION**?
- MASTERING **CARBIDE** MACHINING

PLUS
OFFICIAL PROGRAMME
HIGH-TECH SYSTEMS 2015
25-26 MARCH, 'S-HERTOGENBOSCH



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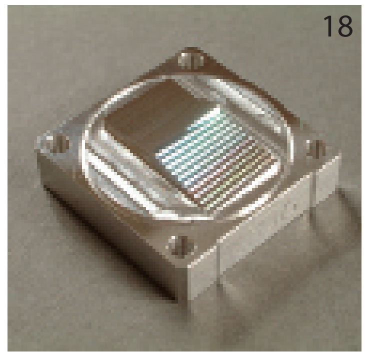

FEATURES

DSPE CERTIFICATION GOES EUROPE

Status

In 2008, DSPE started to select and certify courses supporting the post-graduate education of precision engineers. Certification means that the content of a course has been accepted by the DSPE certification committee as suitable to significantly increase the craftsmanship of precision engineers. Candidates who have followed a certified course receive at the end, besides proof of having followed that specific course (a certificate), also a number of credit points which lead ultimately to the qualification of Certified Precision Engineer, CPE.

Each certified course entitles the candidate to a number of credit points corresponding to the number of formal course days. Any candidate who has collected 45 credit points in total will be awarded the title of CPE. Today a total of 25 courses have been DSPE-certified. In 2013, DSPE passed the milestone of the 1,000th certificate being awarded to a candidate.

Future

Changes will occur this year. An update of the course list on the DSPE site is due, reflecting the dynamics in the courses with material constantly being updated based on trends in the technology and on the much appreciated feedback of the course participants. Secondly, DSPE has started collaboration with euspen, the European Society for Precision Engineering and Nanotechnology. The goal is to expand the DSPE model of certified courses and a certification process as 'best practice' to a European scale, supported by euspen.

For DSPE this means that existing courses, pending an update in English where needed, will receive a euspen certification valid in Europe. For candidates who have followed certified courses this means that their education will be recognised not only in the Netherlands but in all of Europe. It will still take 45 credit points to obtain the title of CPE, but from now on it will be recognised Europe-wide. Last but not least, for the content partners supplying the courses there is the advantage that they now can potentially tap into a much larger pool of candidates. Later this year, the process of having DSPE-certified courses obtain the euspen label will be completed.

Looking forward, we are also working on an update of the certification process itself, together with euspen, for new courses. The option of euspen member(s) participating in the DSPE certification committee and vice versa is under consideration.

All in all, 2015 will be an exciting year.

Jan-Willem Martens
Chairman DSPE certification committee
www.dspe.nl/education

ROLL-TO-ROLL INTO THE FUTURE

Flexible electronics has the potential to change the way people decorate their living rooms, wear and use a watch, or measure their daily health levels. Displays rollable from the ceiling, very thin solar cells and batteries that wrap around an automobile body and sensors that bend around an airplane fuselage or around our wrist are becoming reality. All these new electronic devices will be manufactured on thin plastic or metallic foils that seamlessly move in roll-to-roll mode (R2R) through thin-film deposition stations.

SORIN G. STAN

AUTHOR'S NOTE

Sorin G. Stan has a broad technical background and holds a Ph.D. in nonlinear automatic control from Eindhoven University of Technology. Currently, he is Program Manager Technology & Business Development at VDL Enabling Technologies Group and VDL FLOW in Eindhoven, the Netherlands.

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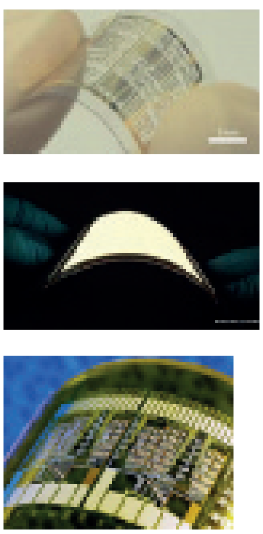
VDL FLOW is an equipment manufacturer and system integrator focussing on the development and realisation of high-performance, novel roll-to-roll (R2R) production equipment for printed, flexible electronics applications. Examples of such applications are flexible OPV, CIGS, PERC and perovskite solar cells, flexible OLED displays and large-area OLED lighting, thin-film sensors and bendable batteries. Many intriguing pictures can be found on the internet, like those shown in Figure 1. FLOW, in the name of the company, stands for Functional Layers on Web.



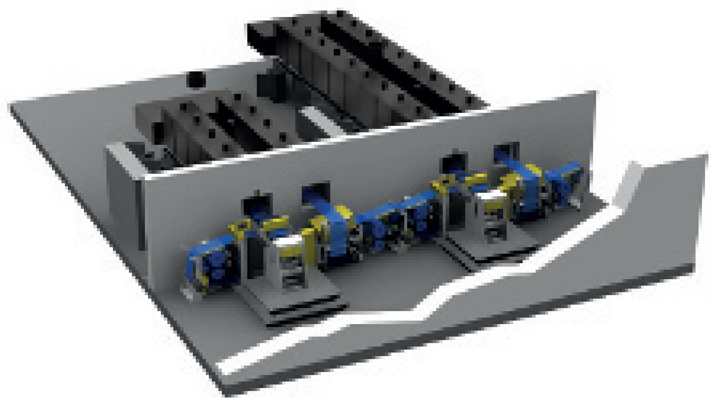
1 *Examples of flexible electronic devices that can already be produced in laboratories.*

VDL FLOW is a newly established technology and market program within VDL Enabling Technologies Group. VDL ETG acquired an international reputation through the supply of parts and equipment to various leading original equipment manufacturers (OEMs) and through the design and realisation of pilot and series production equipment in a large variety of industrial sectors. In turn, VDL FLOW makes use of the rich, unique expertise of its parent company in precision machining, extremely accurate handling and positioning (down to micrometer and nanometer levels) of all sorts of substrates, cleanroom assembly, vacuum technologies, and final integration and qualification of highly complex systems.

All R2R concepts of VDL FLOW enable the manufacturing of flexible electronic devices at atmospheric pressure while handling the webs with extreme accuracy under cleanroom conditions. The equipment provides flexibility for R&D, pilot production and high-yield mass manufacturing at low cost of ownership by excluding the vacuum environment from the production processes.

Compact layout

One of the most interesting equipment layouts developed during the past two years is illustrated in Figure 2. Generally speaking, all conventional R2R production lines stretch over long distances and can easily reach 50-100 meters in length. By contrast, the concept depicted in Figure 2 places the ovens used for drying and curing the coated thin film perpendicularly to the unwinding and



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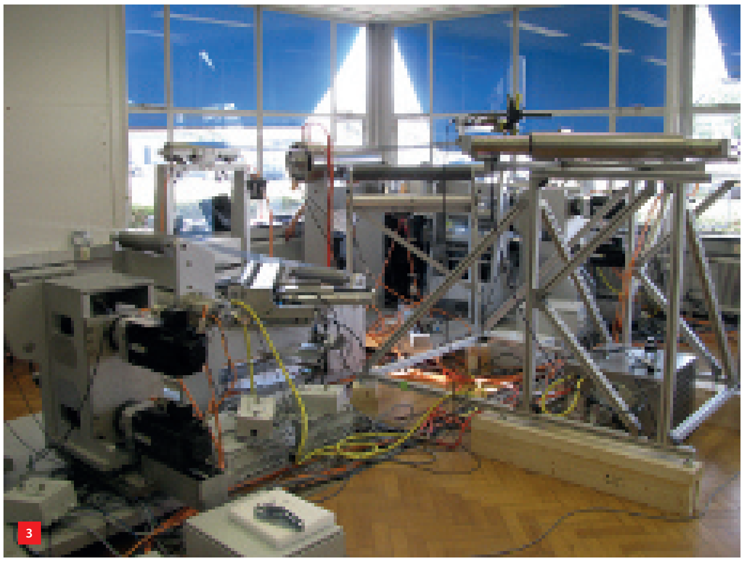

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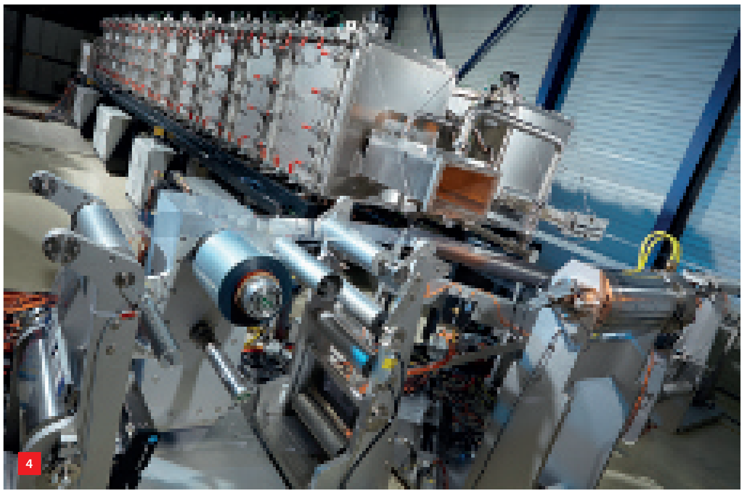

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winding directions of the flexible substrate. This has been achieved by introducing an ingenious mechatronics solution: turning the web 90° while still accurately controlling the web positioning over the rollers. Additionally, the web is turned horizontally 180° inside the oven to enable such a compact machine layout. The new configuration allows for the placement of the ovens outside the cleanroom, enables more flexibility in changing the production processes depending on the end product, and ensures a smooth upscaling from pilot to mass production.

Features

Several unique features distinguish this new equipment layout from the conventional in-line R2R production tools:

- Web handling without touching the functional side of the web.
- Air-bearing handling of the web for increased web control and to accommodate in the future dual-side thin-film deposition technologies.
- Expandable or replaceable curing stations for easy scalability toward higher web speeds.
- Possibility to combine R2R and S2S (sheet-to-sheet) processes.
- Very low cost of the cleanroom when contamination-free environments are required.
- Small footprint on the factory floor.
- Extremely accurate control of lateral web positioning at the process drum, of the web speed, and of the web tension.

The realisation of the R2R printing and coating line has proven to be extremely challenging from several points of view. It became clear already during the design phase that covering web speeds between 1 and 30 m/min while preserving an extremely accurate web speed control throughout the entire speed range, could not be realised without dedicated electrical engines and drives. The speed tolerance on the printing drum was specified below 0.1% and the web tension tolerance was set to remain under 1.5% or maximum 2.5 N all the time. Many weeks of prototyping were needed as well to prove the functionality of each designed module, of the overall mechatronic system and of the target specifications. A glimpse of these activities is shown in Figure 3.

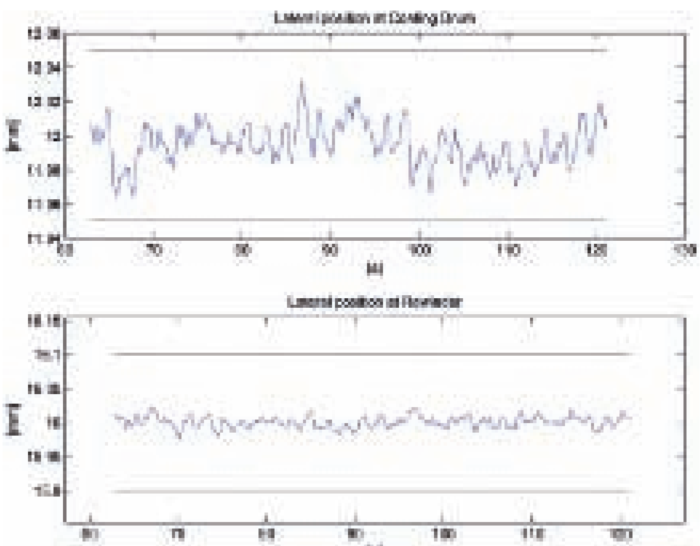
2 New R2R manufacturing concept for printing and coating of flexible electronic devices.

3 The prototyping phase of all mechatronic concepts.

4 The R2R printing and coating line during the factory acceptance tests.

Accuracy

The web handling was afterwards fully integrated with the curing stations, and the entire web transport without touching the flexible substrate was tuned and tested again and again in configurations like in Figure 4. The machine achieved an unprecedented accuracy worldwide on R2R lines in positioning the web in the lateral direction. Less than 20 µm peak-to-peak could be measured on the printing drum as indicated in the measurement on Figure 5. This specification could practically enable the production of



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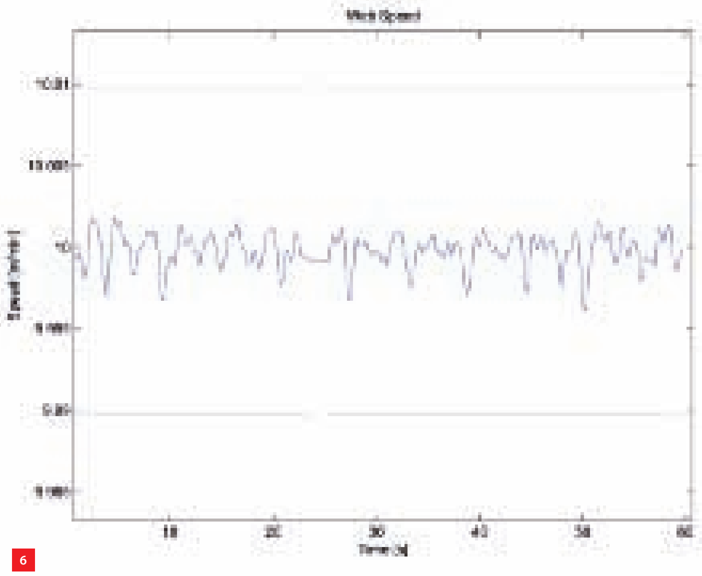

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flexible displays directly onto plastic foils. The accuracy of the web speed can easily be deducted from Figure 6, where the plot clearly stays within ±0.1%.

Solliance

Once the machine passed all factory tests, it was reassembled at the customer location at the High Tech Campus in Eindhoven, the Netherlands. Solliance, a research organisation formed by Dutch, Belgian and German institutes, will use this R2R equipment to develop new functional thin-layer stacks for organic solar cells, large-area OLED lighting, flexible batteries, etc. The parallel R2R lines are being commissioned at the time of writing this article. The cleanroom where the printing and coating stations are installed is shown in Figure 7.

5 *The extreme accuracy of laterally positioning the web.*

6 *The accuracy of the web speed.*

7 *The printing and coating stations located in the process cleanroom at Solliance. (Photo: Bart van Overbeeke)*

In other core activities, VDL FLOW focusses on building a new R2R spatial atomic layer deposition (SALD) machine operating at atmospheric pressure, and on designing and building customised assembly lines for the R2R back-end manufacturing stages of flexible electronics. The ALD tool is based on a concept developed by the Dutch applied research organisation TNO.

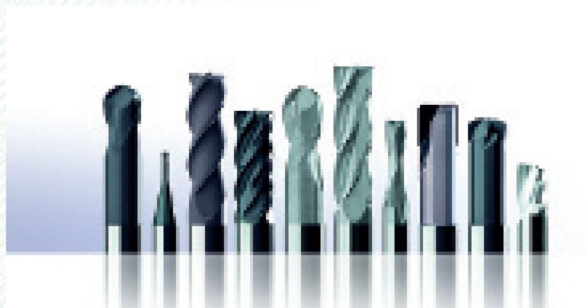
Acknowledgement

These achievements have been made possible due to the out-of-the-box conceptual thinking, the driving energy, and the extremely hard work of an enthusiast team of about 15 people at VDL FLOW. Essentially, the management of the parent companies VDL ETG and VDL Group in Eindhoven believed in this work and in paving the way worldwide for the R2R mass production of printed, flexible electronics. ■

7

MASTERING CARBIDE MACHINING OF PRECISION END MILLS

Highly accurate machining of the world's second hardest material – carbide – with the hardest material ever – diamond. This represents the craftsmanship of Van Hoorn Carbide in Weert, the Netherlands. Thanks to this craftsmanship Van Hoorn Carbide is able to produce precision end mills directly from solid carbide. To optimally adapt this milling tool to cutting process conditions, Van Hoorn delivers end mills in an enormous variety: different numbers of flutes, diameters, helix angles, end faces and coatings.



FRANS ZUURVEEN

In 1990, Peter van Hoorn and his wife started a trading agency selling tools for the metal cutting industry. Some years later the young company expanded and slowly began to manufacture some tools in-house. Thus Van Hoorn gradually learned how to machine carbide, also called hard metal. In 1998, large investments were made in highly sophisticated computer-controlled machinery in order to produce high-speed end mills directly from solid carbide. In 2006, Van Hoorn's second generation became responsible for the firm's management: Ralph and Patrick van Hoorn. Today Van Hoorn Carbide disposes of a work force of nearly a hundred people and an impressive range of precision grinding machines, see Figure 1.

AUTHOR'S NOTE

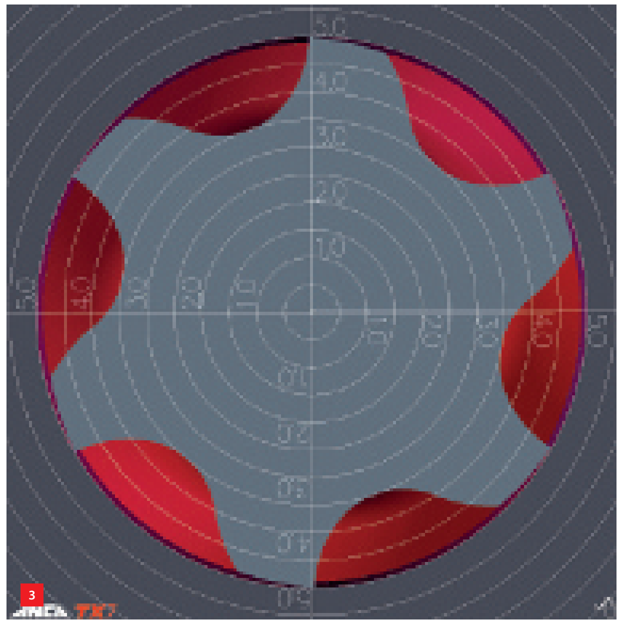
Frans Zuurveen is a freelance text writer who lives in Vlissingen, the Netherlands.

1 *Van Hoorn Carbide invested in an impressive range of precision grinding machines.*

Ralph van Hoorn doesn't deny that his firm is not the only manufacturer of milling tools in solid carbide. But he does emphasise that Van Hoorn not only produces end mills as such, but is unique in providing customers with extensive advice about cutting technology for their products. For that purpose Van Hoorn Carbide disposes of a precision demonstration and testing centre with a Swiss Mikron VCP 600 with a spindle speed of 20,000 rpm^{-1}. In this centre cutting conditions for difficult products, including laminated composite materials, special aluminium and copper alloys, notoriously difficult to machine titanium alloys, etc., are investigated to help customers to reduce machining times and to improve accuracies.

Carbides and coatings

Carbide has the reputation of being a rather brittle material and seems hardly suitable to withstand high cutting forces. But Ralph van Hoorn explains that carbide is strong (tensile strength about 350 MPa), stiff (Young's modulus about 550 GPa) and extremely hard (Mohs' hardness 9.5) with the only disadvantage being that it is not very shock load-



2 *A Van Hoorn end mill with four flutes.*
3 *Cross section of a six-flute end mill with negative rake angles.*

resistant. That's one of the reasons for manufacturing carbide end mills with an excellent radial run-out accuracy, a few microns, to guarantee a smooth cutting load distribution. Van Hoorn mill shafts mostly have an h5-fit as well, which means a tolerance field of 0 to –5 μm for the smallest end mills. Accurate clamping tools, shrink or hydraulic vices are recommended. All these measures help to minimise eccentricities in order to smoothen cutting forces.

Another method to minimise shock loads is to apply end mills with four flutes or more, see Figure 2. In this way, two or more cutting edges are always continuously in operation, thus reducing shocks due to entering the work piece material. And of course, Van Hoorn recommends highly stable milling machines.
Van Hoorn Carbide applies up to eight kinds of sintered carbide. This always consists of ultra-fine tungsten carbide grains in a substrate of cobalt with the addition of other carbides. Van Hoorn uses carbides in round bars, supplied by external suppliers. The first manufacturing step is to accurately grind them centerless.

In most cases, end mills are provided with a coating, which may be diamond or TiAlN for example. But for higher dimensional accuracy the shafts always remain uncoated. Coatings serve to improve cutting conditions, resulting in longer tool life. For the time being, external suppliers will still take care of coating operations, but Van Hoorn is currently building its own coating facilities aiming at improving the quality and reliability of the process.

Variations in milling technology

Several terms are connected with milling technology: high-speed milling (HSM), high-performance milling (HPM), hard milling and micro-milling. Needless to say, Van Hoorn's end mills are individually designed with one of these applications in mind. It will be clear that HSM and HPM differ regarding material removal rate and other aspects, but we will not deal with details of these machining processes here.

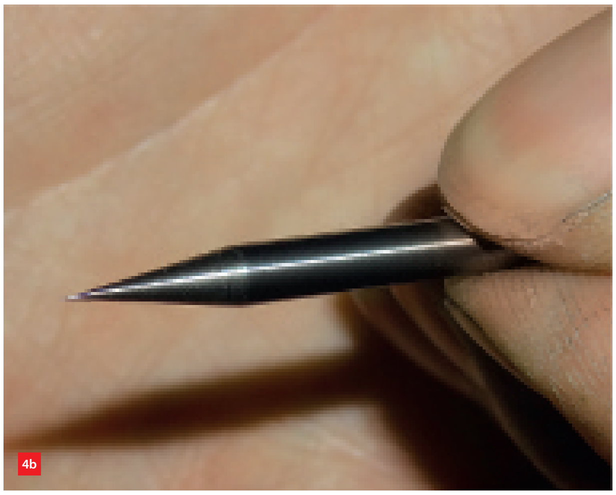
Another well-known milling technology aspect is the difference between climb milling and conventional milling. In nine cases out of ten, climb milling (chip thickness begins at maximum and decreases) is preferred over conventional milling (chip thickness begins at zero and increases), because of better chip removal and surface quality.

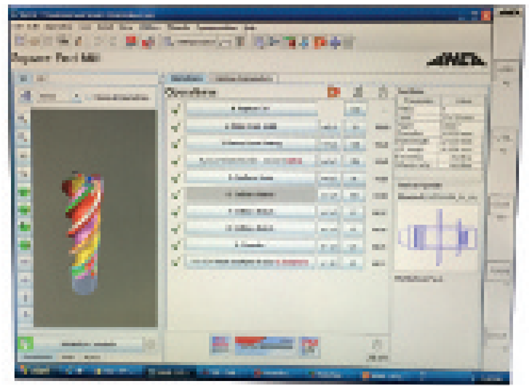
Comparable with hard turning, hard milling is characterised by cutting with a negative rake angle. This requires extremely stiff machinery, because pliant machine components cause vibrations, which result in tool failure. Figure 3 shows the cross section of a six-flute end mill with negative rake angles, specially designed for hard milling. The obvious advantage of hard milling and turning is that a subsequent finishing operation by grinding is not necessary, lowering production costs.

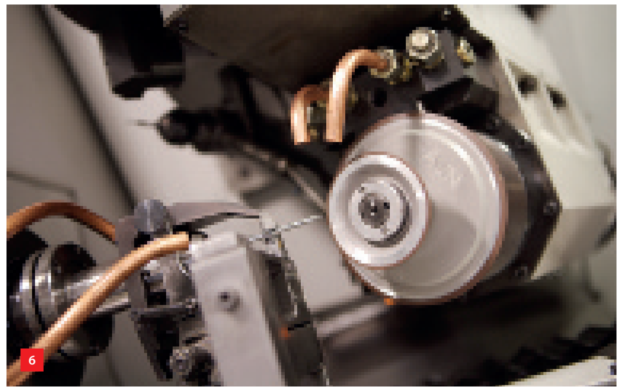
Hard milling is applicable up to a hardness of 65 HRC. The machining process differs from conventional milling through the extremely high temperature at the tool edge. This causes the work piece material to become plasticised, resulting in a kind of "pressing material away" instead of really cutting it.

Micro-milling

Without doubt, micro-milling is a technology that has to be regarded as a powerful weapon for precision engineers. But when does conventional milling become micro-milling? When observing Van Hoorn's end mills with a diameter of only 100 μm, see Figure 4, this precision product quite certainly has to be regarded as a micro end mill.







Micro-milling is much more susceptible to run-out deviations of the clamped tool than standard milling. A run-out of only 5 μm means a considerable part of the cutting diameter of the smallest micro end mill, causing a relatively heavy shock load when compared with conventional milling and therefore faster tool wear and a shorter tool life. That's also why all mill grinding processes are performed during a single clamping cycle.

Grinding precision end mills

Figure 5 lists the successive steps necessary to produce an end mill. Figure 6 shows the opened grinding machine and Figure 7 the actual grinding process with an ample supply of cooling machining fluid, which is a special kind of cutting oil. The machine is provided with automated grinding wheel exchange and work piece in- and output, enabling continuous 24/7 operation. The grinding wheel not only consists of extremely small diamond particles in a plastic, ceramic or metal substrate, but it is also provided with an extremely small radius, 10 to 20 μm, when making flutes in micro end mills.

The main problem when making a micro end mill is avoiding work piece deformation due to cutting forces. The solution to this problem is the application of special work piece supports as near as possible to the grinding wheel. At two diametrically opposite positions, V-like supports in carbide press against the work piece. Each support consists of two accurately machined prisms. To guarantee optimal support, this combination moves along the work piece at a constant distance in relation to the grinding wheel. Needless to say, the machining fluid also lubricates this supporting device.

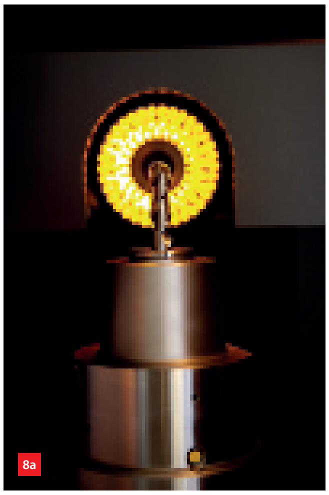
4 *A micro end mill with a cutting diameter of only 100 μm.*
(a) Design.
(b) Realisation.

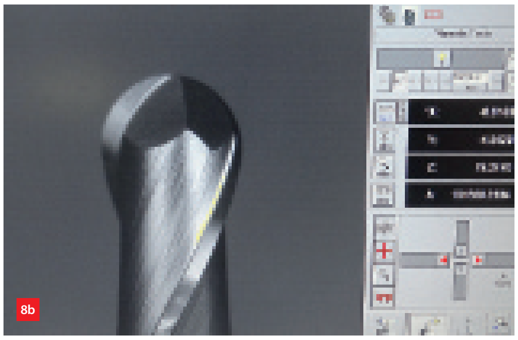
5 *The successive steps in grinding an end mill, providing highly accurate freeforms, including rake and clearing surfaces.*

6 *Opened grinding machine with grinding wheel at right and clamped work piece in the centre.*

7 *Grinding with an ample supply of cooling machining fluid.*

Measuring and testing constitutes an important element of the Van Hoorn Carbide production process. Not only is every single product visually inspected, but a sample of 5%





8 *Measurement of end mills.*
(a) Test set-up for video-measuring.
(b) Display of results.

is measured before the end face cutting edges have been machined. The tool's cross section can then better be observed for a more accurate determination of tool cutting parameters. Apart from that, the completed end mills are measured at random, see Figure 8.

Research

Van Hoorn Carbide disposes of a research room, where new concepts for end mills are investigated. For that purpose Van Hoorn also cooperates with TNO Science and Industry [1]. Of course, such new designs are extensively tested in the testing centre with the Swiss Mikron machine referred to above. Ralph van Hoorn suggests that very promising end mill innovations are on their way, but quite understandably refuses to unveil them before they are thoroughly tested. Nevertheless, it is remarkable that one single product only – an end mill – is able to evoke so much sophistication. ■

REFERENCE

[1] R. Blom, P. Li, H. Langen, A. Hoogstrate, H. Oosterling, P. van den Hof, and R. Munnig Schmidt, "Towards industrial applications – Improving micro-milling technology", *Mikroniek*, Vol. 50 (1), pp. 6-11, 2010.

INFORMATION
WWW.HOORN-CARBIDE.COM

COLUMN

A PATENT: THE STIMULATOR OF INNOVATION

When it comes to patents, many prejudices and misconceptions exist. They have a reputation of being expensive, requiring a lot of time, and, perhaps, even being futile. Endless conflicts between companies such as Apple and Samsung seemingly display a system in which time and money are invested with very little to no result when it comes to the protection of an invention. This while the core purpose of the patenting system is the constant promotion of innovation and progress in the development of technology.

I often encounter people who regard a patent as a means to a monopoly position, a legal ban on third parties to use an invention. This is explicitly not the purpose of a patent system. Naturally, a patent provides the patent holder with an exclusive right to produce and sell his invention, thereby generating revenue. However, the patent holder is legally encouraged, of course in exchange for a reasonable fee, to provide others access to the invention. The patent system would surpass its purpose if indeed an invention is made which would be used nowhere in the world because of patent protection. If anything, the patent system is designed to spread innovation rapidly and lucratively across the globe.

So how is this 'forced' sharing of an invention not a restriction of owning a patent? Simply put, the sharing of an invention rather stimulates the market position of an individual patent holder and the general development within a field. A patent application appears as a publication within the patent literature, making this information globally available. The global disclosure of an invention without a patent leads to unrestricted copying. The alternative is keeping an invention secret, which restricts the potential sale of licensing rights. This while a patent can be an excellent means of rapidly spreading an invention across a market. The option of selling licensing rights means you are not restricted to manufacturing your invention yourself and can outsource any aspect of its manufacturing and marketing to ensure your position within the market. Take as example the Dutch storm umbrella, SENZ, which, after overtaking Europe, successfully found the US market through a licensing agreement.

But let's get back to the patent itself. The global disclosure of an invention in the form of a patent application not only makes others aware of the opportunity to obtain a licensing right. It also encourages experts within a field to, on the basis of an invention, come up with further innovation, which in turn will also become part of the patent literature. It is an exchange of protection in return for a contribution to public know-how. Hence, the drive towards innovation is unceasing and more and more advanced products become continuously available. So, whereas conflicts between Apple and Samsung may appear futile at first, they are in fact an indication of an industry at the pinnacle of innovation. In the end, non-patenting enables copying, whereas patenting stimulates progress.

Wouter Kempes
Patent attorney, DOGIO Patents
www.dogiopatents.nl

Patent Licences Database

The Dutch government stimulates the cooperation between patent holders and entrepreneurs through a a database for patent licenses that was launched in late 2014. Anyone can gain insight into which technologies exist and which are on offer, facilitating the trade in licensing agreements, and as such the rapid advancement of innovation. The Databank Octrooilicenties (Patent Licences Database) is an initiatieve of Octrooicentrum Nederland, part of RVO.nl, the Netherlands Enterprise Agency.

www.octrooilicenties.nl/xslweb/LDB-browser/index

MASTERING COMPLEXITY IN SYSTEM INTEGRATION

The High Tech Systems Center (HTSC) of Eindhoven University of Technology (TU/e) is the university's response to the increasing demand from industry for fundamental research and development in the area of high-tech equipment and instrumentation addressing today's societal challenges. On 8 January 2015, a kick-off symposium titled "Mastering complexity in system integration" was organised in Eindhoven, the Netherlands, featuring an introduction to HTSC's vision and some thought-provoking presentations.

Hans van Duijn, Rector Magnificus of TU/e, gave a short welcome speech to the 250+ participants (Figure 1) and kicked off with an introduction of his university ("Number one in industrial co-authorship for scientific publications"). Concerning the reasons for establishing the HTSC, he spoke of a paradigm shift: "We have to educate a new generation of system thinkers." The engineer of the future, according to Van Duijn, strives for excellence, is able to connect education and research, cooperates with industry, works in a multidisciplinary setting and has an entrepreneurial spirit.

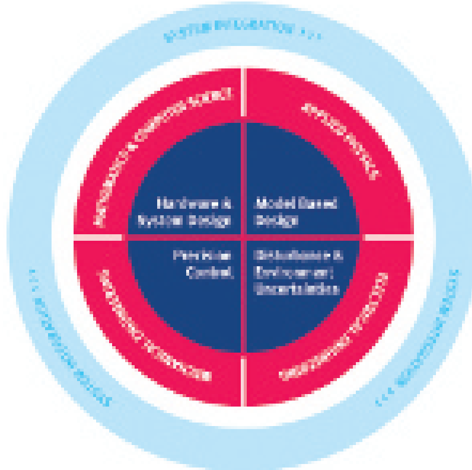
1 *The kick-off symposium attracted a decent crowd to the TU/e campus. In the foreground is chairman of the day, Frank Sperling, HTSC Programme Manager. (Photos courtesy of Ruud Strobbe)*

Multidisciplinary systems engineering

Next, the HTSC was introduced by Maarten Steinbuch (Figure 2), Distinguished University Professor at TU/e working on systems and control, and HTSC Scientific Director. See also the box on the HTSC philosophy and mission. Steinbuch briefly sketched out the recent history of research funding for precision engineering and high-tech systems design in the Netherlands. In the traditional approach of combining monodisciplines, the performance that can be achieved for high-tech systems has reached saturation point. The challenge, according to Steinbuch, is to increase the performance of high-tech systems through truly multidisciplinary systems engineering.

In academia, however, the monodisiciplines still constitute the basis of the curriculum and systems engineering is not a full-blown discipline of its own. Ultimately it is a trade that has to be learnt in practice. Therefore, the HTSC has engaged industrial fellows that supervise the research programmes. These fellows come from the large OEMs in the Brainport Eindhoven region, but the HTSC seeks cooperation with high-tech SMEs as well.

Steinbuch illustrated the systems engineering approach with best practices in the design of healthcare systems, printing systems, automatic food processing and wafer stage control. He concluded with a "man-on-the-moon" statement: "If we really co-operate, we can do incredible things…from freeform fluid control to mechatronic bees."



2 *Katja Pahnke, Managing Director, and Maarten Steinbuch, Scientific Director, introduced the HTSC. (Photo: Bart van Overbeeke)*

3 *The HTSC model of multidisciplinary systems engineering/systems integration centers around four themes that constitute HTSC's four research programmes.*

Katja Pahnke (Figure 2), Director of TMC Technology Executives and HTSC Managing Director, went into detail about the organisation of the HTSC as a strategic alliance of (initially) four key engineering departments of TU/e, with four multidisciplinary research programmes (see Figure 3): Hardware & System Design; Model Based Design; Disturbances & Environment Uncertainties; and Precision Control. In 2020, the HTSC aims to have 200 PhD students and thirty PDEng (Professional Doctorate in Engineering) students.

The value of advanced control

First guest speaker was Tariq Samad, Corporate Fellow with Honeywell Automation and Control Solutions, based in Minneapolis, USA. He confessed he was "blown away by the level of sophistication" of TU/e research and the degree of industry-academia interaction.

HTSC philosophy

The philosophy of the newly established center is briefly outlined on the HTSC website. In next-generation high-tech and mechatronic systems, it reads, extreme functionality and performance requirements will be realised by using a model-based multi-physics systems approach. New sensor technologies and actuator designs for multi-physics processes (forces, flows, temperatures, acoustics, optics) have to be integrated with and used by distributed on-line model-based control and optimisation tools. The control systems are adaptive, auto-tuned, are implemented in optimised hardware and software architectures, and use effective (wireless) communication.

Systems will require further integration, the website text continues: all of the physics, including material properties, becomes important to model and to control. Control, communication and software will interact interdependently to achieve the real-time performance requirements. Systems engineering must be further developed as a systematic tool for the conception, design and performance prediction of complex equipment.

Derived from this philosophy, HTSC's mission is:

- To understand, teach and innovate system synthesis and design of complex equipment, instruments, robotic and manufacturing systems and systems-of-systems – employing in-depth understanding of the classical engineering fields together with model-based systems engineering to conceive, predict and verify cutting-edge system functionalities and architecture.
- To realise leadership in advanced multidisciplinary research in the field of complex systems. The fundamental research question is how to master 'cyber-physical systems' for future-generation mechatronic and manufacturing systems, which are extremely accurate or fast, but also affordable.
- To be the primary driver and network center of the Dutch mechatronics ecosystem, actively supporting and initiating cooperation between OEMs, SMEs and knowledge institutes.

The kick-off symposium on 8 January 2015 provided a successful first step on HTSC's mission.

WWW.TUE.NL/HTSC

Samad's talk was titled "Innovation in Systems and Control: Identifying and Exploiting New Opportunities". Following an overview of Honeywell's advanced controls activities, he stressed the importance of systems engineering and integration. "Control algorithm design cannot be isolated from its deployment environment." Examples of Honeywell innovations from R&D in the Netherlands/Europe, and from the second edition of "The Impact of Control Technology", co-authored by Samad, illustrated the value that advanced control can offer the end user. As an example he quoted $1 per barrel savings achieved in an oil industry project.

Critical mass

As a representative of the renowned Dutch high-tech ecosystem, Guustaaf Savenije, CTO at Eindhoven-based VDL Enabling Technologies Group (ETG), presented his vision on innovation in the supply chain. In his opinion, consolidation is the leading trend in the semiconductor supply chain: at the device manufacturer level (Samsung, TSMC, Intel), at the equipment OEMs (ASML, Applied Materials, KLA-Tencor, Lam Research), and in the supply chain (Foxconn, Flextronics, Jabil, VDL ETG, etc.)

With increasing equipment cost and cost of innovation, every chain party wants to 'climb up': take over more responsibility from the customer and delegate more work to the supplier. The supply chain needs to transform itself from build-to-print to build-to-specification/roadmap. In this new model, system suppliers, such as Savenije's VDL ETG, assume function ownership and focus on Total Cost of Ownership & Life Cycle Management. "To be able to do this, one needs the total view: systems engineering." To support this transformation and to keep the Dutch high-tech systems industry in the global race, critical mass is needed. According to Guustaaf Savenije, this is HTSC's raison d'être: "A world class research center for a world class ecosystem."

The real needs in healthcare

Healthcare is one of the promising application fields of modern technology, but there is a mismatch between the

Posters in control

During the HTSC Kick-Off symposium, posters were displayed that represented research under the HTSC umbrella (see Figure 4). Many of them centered on the subject of control.

One example is "Advanced Feedforward and Learning Control for High Tech Motion Systems" by Joost Bolder and Frank Boeren, both PhD students in the TU/e Control Systems Technology group (Department of Mechanical Engineering). In their research, supported by Océ-Technologies and Philips Innovation Services, they employ a data-based optimisation algorithm to study real-life cases from Philips (wafer positioning, the challenge being exceptional accuracy in the nanometer range), Océ (printing, with exceptional variation in tasks) and NXP-ITEC (die-bonding, with exceptional throughputs of > 90,000 lots/hour). With a combination of high performance and flexibility they manage to successfully control a range of industrial high-tech systems.
Another poster featured "Observers for high tech systems – Improving tracking performance through estimation of flexible dynamics". Koen Verkerk, PhD student in the TU/e Control Systems group (Department of Electrical Engineering), investigates how the application of a state estimator can be used to mitigate the effects of flexible dynamics on the feedback control bandwidth and high-tech system performance.

4 *The HTSC kick-off symposium side programme featured demos and poster presentations.*

medical technology that is currently being developed and the future care needs. That message was brought to the high-tech systems audience in Eindhoven by Luc de Witte, Lector at Zuyd University of Applied Sciences and Professor of Technology in Care at Maastricht University.

Healthcare needs a serious transformation, said De Witte, with less emphasis on cure and more on prevention and long-term care. The patient will be in the driving seat and people with disabilities and the elderly will have to live independently for much longer, meaning that self-management comes first and that technology for diagnosis, monitoring, ADL (all-day living) support and treatment at home will become standard.

So there is potential for assistive technology, such as mobility support or care robotics. De Witte presented results of systematic reviews, regarding robots for the elderly and arm supports, that confirmed the massive research effort in this field. Up to 100 cases each were found in the two studies, but results to date are disappointing in terms of usability/effectiveness: the robots under development will probably not help to keep elderly people independent, most arm supports are simply not good enough. His conclusion was that there are ample challenges for medical professionals and technologists working together on innovation: bridging cultures, making things ‘dummy proof’, focussing on implementation, fighting financial barriers etc. But the good news is: in cure as well as long-term care - high-tech is needed.

Third-generation university

In his closing statement, Jan Mengelers, President of the TU/e Executive Board, put the founding of the HTSC in the perspective of the academic evolution in Western society, from education-oriented to education & research-centered universities to a third generation, focussed on education, research & know-how exploitation. Their method is interdisciplinary science, their focus is on creating value, and that is precisely what Eindhoven University’s HTSC is aimed at: creating value through multidisciplinary systems engineering. ■

WHAT'S UP?

The definition of what constitutes Ultra Precision (compared to precision or high precision) is very much open to interpretation. Some claim it is working with very small feature sizes, others that it's related to the smoothness of the surface finish, or the level of defects in a product. To some extent all are true. There is however a more universal way of looking at the definition, and that is through a scale, either a scale of work piece to minimum feature size, or possibly more usefully work area to smallest measured physical controlled dimension. This article presents the UK perspective.

MARTIN O'HARA

The UK's manufacturing background

The UK has a long history of manufacturing, going back centuries. In recent years there has been greater political focus on other sectors, in particular service and finance. But even so, the UK has maintained a strong manufacturing base and is still the 11th largest industrial manufacturing country globally (World Bank, 2013). Not only does manufacturing represent just under €200 billion of gross domestic product and employ 2.6 million people in the UK, but according to the Office for National Statistic (ONS) it also has the largest investment in R&D of any sector, consuming 75% of UK R&D investment in 2011 (last available data). This manufacturing is not all for internal consumption, in fact just over half (54%) goes to export markets.

However, it is well recognised that within this data lie significant hidden changes. The businesses in manufacturing are fewer of the giants such as Rolls-Royce and Jaguar-Land Rover, but more small and medium-sized enterprises (SMEs), which constitute 57% of the manufacturing output. As with all developed economies, the nature of manufacturing has also changed. Although 2.6M is still a large number in employment, the reality is that many of the jobs require significantly higher skills than previously in manufacturing and much of the manufacturing process itself is now highly automated.

Another hidden aspect is the increase in precision that has been required to improve product yield and quality, to maintain a lead for the UK in manufacturing. Having access to processes and technology that are beyond the 'common level' is how developed economies have maintained their manufacturing bases and this is the key to them maintaining a manufacturing industry into the future.

How is Ultra Precision defined?

Unfortunately there is no clear-cut definition of what constitutes Ultra Precision (UP), and the moniker has been misused in the past as indicating nanoscale production. Having a single numerical definition is too crude to fully capture the true extent of what Ultra Precision really means and at best it is defined as a scale.

In terms of machining for example, it is when the ratio of overall work-piece size to smallest produced feature size exceeds 1 million to 1 (1,000,000:1, see Figure 1). Even this definition is not always adequate, as it assumes a static work piece and a single control dimension. Clearly, not only can the dimensional control be more complex, but the term could also be applied to a flow process. In a flow process the relationship will be between minimum feature or control dimension (e.g. alignment) and work-area flow rate at a ratio of 100 thousand to 1 (100,000:1, see Figure 2). The most obvious modern application area for this would be the production equipment for flexible substrate based electronics (i.e. printed/plastic electronics). Consequently, in flow production increasing the flow rate alone can be the manufacturing parameter that specifies the Ultra Precision technologies that are to be employed

UP research in the UK

Fewer businesses have the resources to conduct their own research these days, and in the UP field most businesses are focussing on application and development of existing technologies. In the UK the Engineering and Physical

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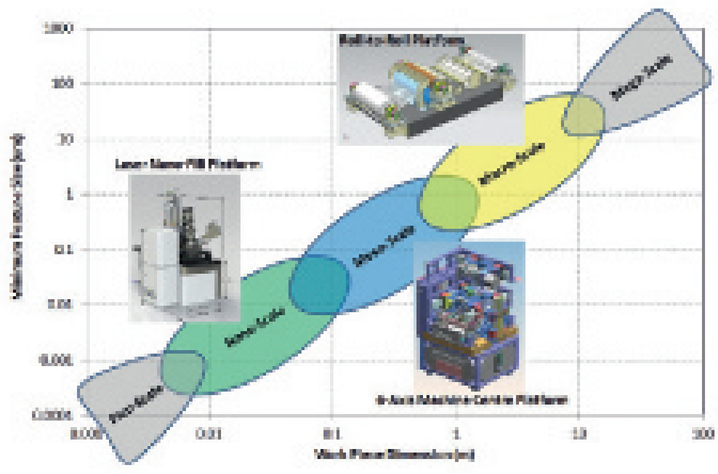

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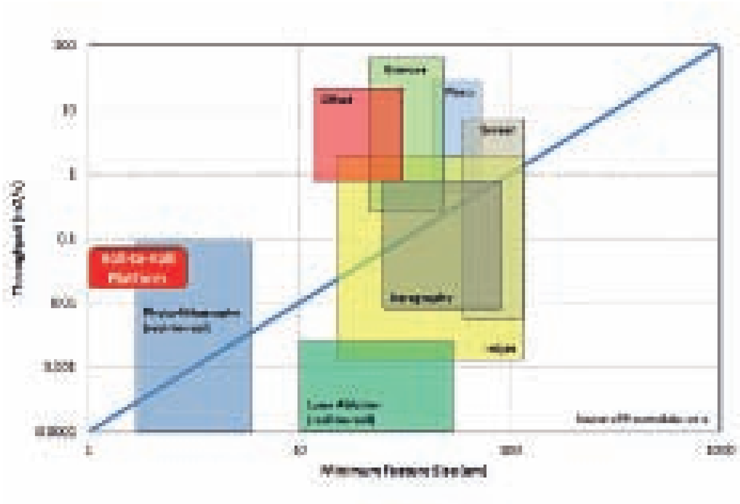

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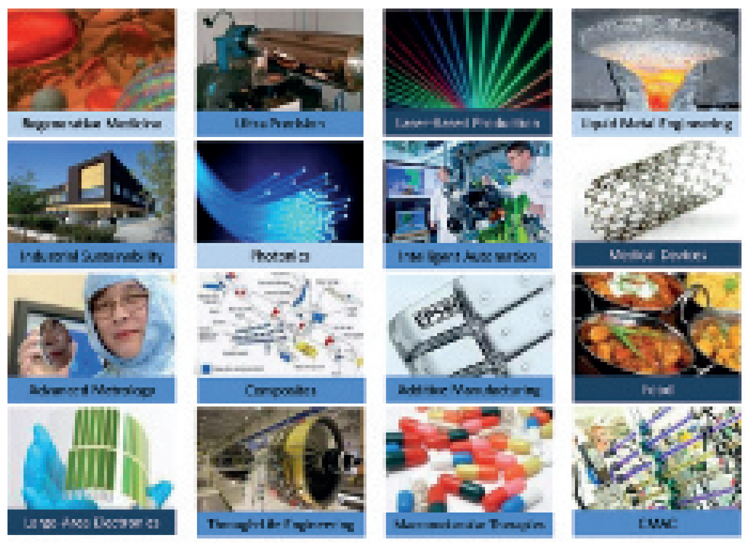

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Sciences Research Council (EPSRC), a body that funds the majority of postgraduates and postgraduate research activity, are actively funding a Centre for Innovative Manufacturing in Ultra Precision; it is one of 16 such centres. These centres all have common aims, but based around different technology areas and encompassing 28 universities (Figure 3).

The aims of each centre are:

- To create, deliver and disseminate world-leading research.
- To address major long-term manufacturing challenges and/or emergent manufacturing opportunities.
- To provide strong support for UK manufacturing industries.
- To enhance the global profile and significance of UK research.
- To create a national network of expertise in manufacturing research knowledge.
- To provide outreach to other centres and relevant research groups.

Each centre is funded for five years to perform research in specific areas. The Ultra Precision centre started in October 2011 as a collaboration between the Precision Engineering Institute at Cranfield University and the Institute for Manufacturing at the University of Cambridge. The centre also runs a separate, but also EPSRC-funded, Centre for Doctoral Training (CDT) which will train over 100 researchers to Doctoral level over the next seven years.

The research of the centre is focussed in the three areas noted on the Ultra Precision scaling graph (Figure 1) via the development of three specific research platforms. In the Nano-scale area a laser-assisted nanometer-scale focussed ion beam milling machine is being developed (Laser Nano-FIB); this will research product developments that require nanometer-scale features, over centimeters of product area in a rapid ultra-precision machining centre. Utilising a hybrid process of laser ablation and FIB milling to achieve smaller feature sizes over large work-piece areas than are presently possible in a single machine, and more rapidly than is possible today to minimise end product cost.

The Meso-scale research platform is a 6-axis micro-machining centre, capable of achieving sub-micron processing within a small-footprint machine, reducing running costs and speeding up the processing time. Some of the unique features of the Meso-scale platform include running from single-phase electrical supply, milli-Kelvin thermal control and the ability to have different processing stages, including atmospheric plasma figuring, on the same

1 *Ultra Precision scaling for static processes, showing three regions of research and the technology platforms being developed by the UK Centre for Innovative Manufacturing in Ultra Precision.*

2 *Ultra Precision scaling for flow processes, illustrating where traditional printing techniques fit (source: Organic Electronics Association (OE-A)) and where the roll-to-roll research platform will fit in this scenario.*

3 *The 16 UK EPSRC Centres for Innovative Manufacturing.*

base unit, which is the size of a typical domestic refrigerator.

The Macro-scale platform is based on a future generation of film processing equipment, where meter-scale film will be processed with micron-sized features and alignment, while being run in a flow process at meters-per-minute production rates. Existing technology in this field is working in the 300-650 mm web width often utilising batch processes on a roll that is stopped for each process stage. The research platform is multiple generations ahead, operating at 1,400 mm (1.4 m) web width with fully continuous flow processing.

There are other areas of UP research being conducted on large-area optics, laser processing and precision control systems for example, but these are on a per-project basis and most work is focussed on developing the tools, technologies and processes for the three research platforms.

UK National Strategy Programme

In the UK the funding also covers dissemination of the research to the UK and wider global community of precision engineers. The primary source is the centre's own website. It is recognised that this is not the complete solution and there is also an outreach programme for both industry and education.

The industrial outreach programme includes a series of UK-based networking events, where technical presentations are made and tours of UK research facilities are organised for delegates. Speakers and visitors from outside the UK are welcome to attend or present and the idea is to ensure UK businesses know what the latest trends and research areas in Ultra Precision are and where these are being performed.

4 *Children design and manufacture their own watch as part of the educational outreach programme: Watch-It-Made™.*

The centre also attends overseas conferences and exhibitions, sometimes as the UK centre itself, and recently has organised a cluster of UK businesses to exhibit under the UP banner at the Dutch Precision Fair 2014.

The educational programme extends from postgraduates to school level. The primary postgraduate outreach is via the CDT based at Cambridge and Cranfield Universities and their annual research conference bringing in other research students in this area. At school level the centre has actively developed an engineering and manufacturing experience for children called Watch-It-Made™, which brings school-aged children into a design and manufacturing studio where they can design, manufacture and build their own wrist watch (Figure 4). The Watch-It-Made experience has proved such a resounding success at engaging school-aged children that it has taken a life of its own and is looking to spin-out as a stand-alone educational business (www.watchitmade.org).

Applications for UP technologies

One of the mantras of the centre is that Ultra Precision is 'application agnostic'; this means that the technology itself is applicable across a broad range of end products and applications. However, there are some areas that illustrate the technology better than others (Figure 5).

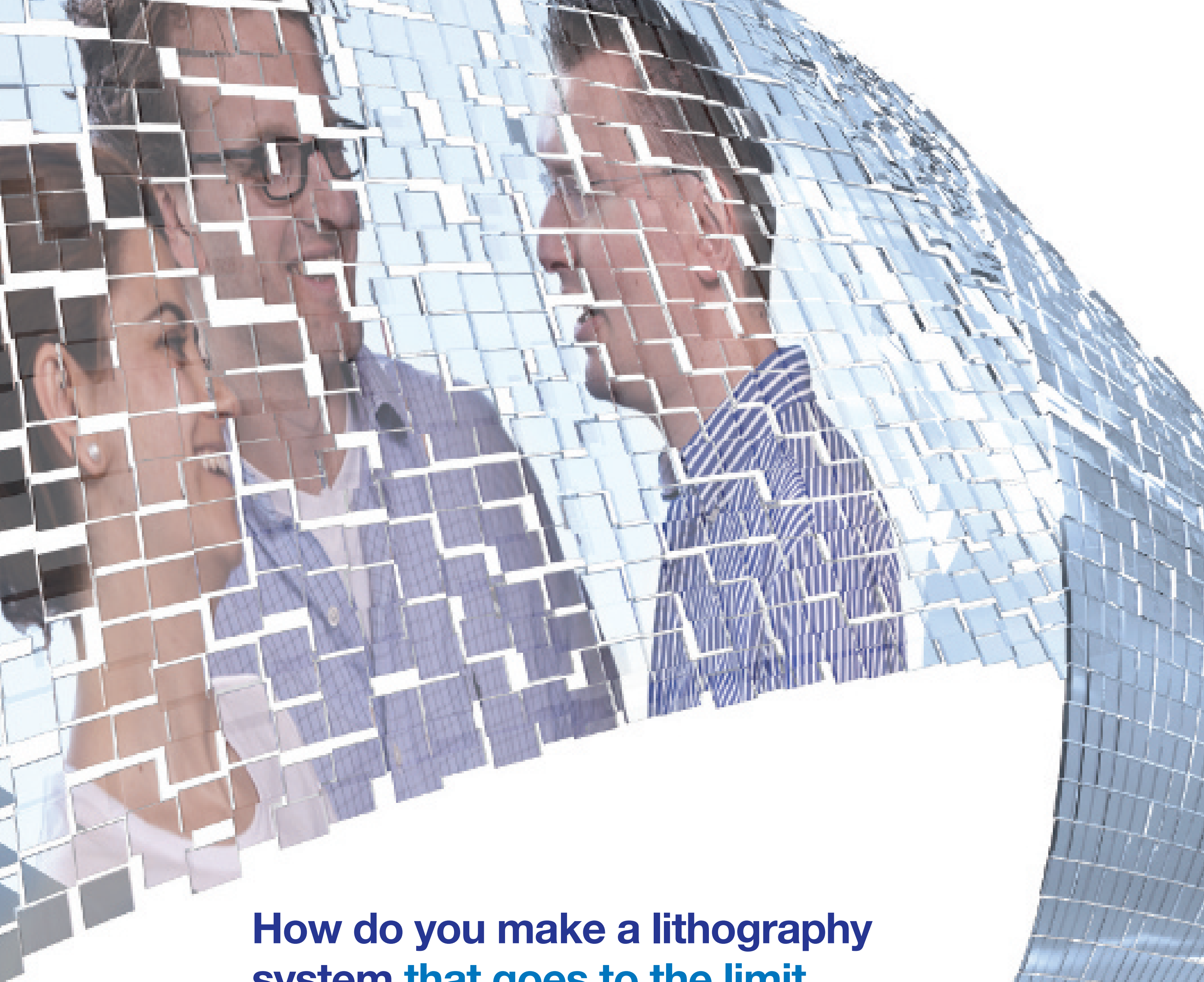
In volume production terms, the ultimate examples of what is Ultra Precision, and why the nanometer reference is so pervasive, is the manufacture of integrated circuits (ICs). The technology for IC patterning is relatively well-known and understood photolithography; however, at the extremes of sub-micron and nanometer scales the traditional techniques are no longer easy to apply and cannot be performed with traditional light sources or simple photo mask methods. Some of the optics required for modern lithography is similar in scale and manufacturing complexity to those produced for large science projects, such as the European Extremely Large Telescope (E-ELT), hence machine processes developed for one application are often applicable to others.

Micro-fluidics is another area in which UP is used to create production-quality processes. The end application can be a moulding tool for an electronic component cooling application or a medical corneal implant with anaesthetic dosing.

Essentially any process or machinery that is required to achieve the level of precision which meets or exceeds the definition given at the start of this article will have UP technology, whether it is labelled as such or not. Some of the technology may at face value look relatively mundane;

such as high-stiffness bearing developments, but is essential for meter-scale plastic film production and many other processes that sometimes require higher levels of repeatability rather than absolute dimensional accuracy. As a consequence, Ultra Precision technology is also helping achieve high quality and low cost in many existing manufacturing environments, including in areas where absolute precision in the product itself is not required. ■

5 *Collage of UP products.*
(a) 1.5m E-ELT mirror segment support.
(b) Porous ceramic air bearings.
(c) Concentrated solar collector 100nm internal coating over 4.5m tube length.
(d) 1.4m embossing roll for micro-surface structured films.
(e) Micro-moulded ocular implants.
(f) Diamond flywheel for sub-5μm surface flats on cast aluminium frames.
(g) Diamond turning of Boltzmann sphere to nm precision.
(h) James Webb Space Telescope image slicer segment.



UPCOMING **EVENTS**

3-5 March 2015, Veldhoven (NL)

RapidPro 2015

The annual event for the total additive manufacturing, rapid prototyping and rapid tooling chain, divided into RapidPro Industrial and RapidPro Home Professional.

WWW.RAPIDPRO.NL

17-18 March 2015, Huddersfield (UK)

Lamdamap 2015

Event focused on laser metrology, machine tool, CMM and robotic performance.

WWW.LAMDAMAP.COM

17-20 March 2015, Ede/Veenendaal (NL)

Demoweek 2015

Eight companies, including Cellro, Heidenhain and Mitutoyo, demonstrate their automation offerings for the metalworking industry: software, robotisation, control, measurement, 3D printing and machining. The theme of this thirteenth edition is 'Efficiency in every dimension'.

WWW.DEMOWEEK.NL

19 March 2015, Rijssen (NL)

Ter Hoek Precision-in-business day

DSPE event at Ter Hoek Vonkerosie, market leader in electrical discharge machining (EDM).

WWW.DSPE.NL/EVENTS/PIB-EVENTS

25-26 March 2015, Den Bosch (NL)

High-Tech Systems 2015

Third edition of this event is aimed at the high-tech systems industry in all European areas with significant high-tech roadmaps. See page 38 ff.

WWW.HIGHTECHSYSTEMS.EU

14 April 2015, Düsseldorf (GE)

Gas Bearing Workshop

An initiative of VDE/VDI GMM, DSPE and the Dutch Consulate-General in Düsseldorf (Germany). For more information see page 44.

WWW.DSPE.NL/CENTRAAL/EVENTS/GAS-BEARING-WORKSHOP

22-23 April 2015, Veldhoven (NL)

Materials 2015, engineering & technology

Trade fair, with exhibition and lecture programme, targeted at product developers, constructors and engineers. The focus is on properties - applications - solutions.

WWW.MATERIALS.NL

22-23 April 2015, 's-Hertogenbosch (NL)

Mocon 2015

Dutch trade show covering industrial motion control and drive technologies. The latest innovations in design, construction, maintenance and use of components and systems will be displayed.

WWW.EASYFAIRS.COM/MOCON-NL

1-5 June 2015, Leuven (BE)

Euspen's 15th International Conference & Exhibition

This event will once again showcase the best international advances in precision engineering fields such as additive manufacturing, medical products, micro-biology, nano & micro manufacturing, metrology, mechatronic systems & control, renewable energy technologies and ultra-precision machines.

Topics:
- Important/Novel Advances in Precision Engineering & Nano Technologies
- Nano & Micro Metrology
- Ultra Precision Manufacturing & Assembly Processes
- Renewable Energy Technologies
- Ultra Precision Machines & Control

WWW.EUSPEN.EU

3-4 June 2015, Veldhoven (NL)

Vision, Robotics & Mechatronics 2015 / Photonics 2015

Combination of two events organised by Mikrocentrum, featuring the RoboNED conference and the PhotonicsNL conference as parallel events.

WWW.VISION-ROBOTICS.NL
WWW.ROBONED.NL
WWW.PHOTONICS-EVENT.NL

22-26 June 2015, Eindhoven (NL)

International Summer school Opto-Mechatronics 2015

Five days of intensive training, organised by DSPE and The High Tech Institute.

WWW.SUMMER-SCHOOL.NL

17-21 August 2015, Leiden (NL)

LiS Academy Summer School Manufacturability

Summer school dedicated to the manufacturabilty of precision components and targeted at young professional engineers with a limited knowledge of and experiences with manufacturing technologies and associated manufacturability aspects.

WWW.LISACADEMY.NL

DRIVING IN THE SUB-NANOMETER RANGE

Piezo actuators allow for motions with a resolution in the sub-nanometer range. They achieve travel up to approximately one millimeter and high dynamics with frequencies up to several thousand Hertz. There are no frictional parts to limit resolution, also no mechanical wear, as motion is based on crystalline solid-state effects. Their service life and reliability, however, strongly depend on the environmental conditions at the site of application.

BIRGIT SCHULZE

Piezo actuators convert electrical energy directly into mechanical energy and allow for motions with a resolution in the sub-nanometer range. Therefore, piezo actuators are the ideal drive solution for many precision applications in industry, life sciences, microscopy, medical engineering and research, and have meanwhile even proven themselves in space. Their service life and reliability strongly depend on the environmental conditions at the site of application. Humidity, temperature and operating voltage are of considerable influence.

Humidity and stress

Since no polymer insulation exists that is absolutely impermeable, the life expectancy for conventional, polymer-insulated piezo actuators can decrease dramatically at high humidity. Ingressing moisture and the electric field applied can then cause chemical reactions in the component, which are accelerated by higher temperature. The result is initially an increased leakage current and finally a dielectric breakdown, that is a short circuit between the electrodes, which can cause irreparable damage to the actuator. During dynamic operation, the service life of the piezo is affected by dynamic forces and alternating mechanical stress conditions; cracks can often lead to quick failure in such cases. The answer lies in optimised materials and manufacturing processes, appropriate design and, last but not least, the choice of suitable insulation.

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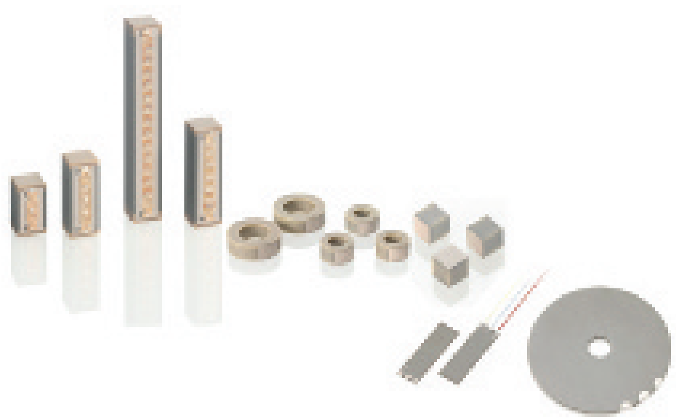
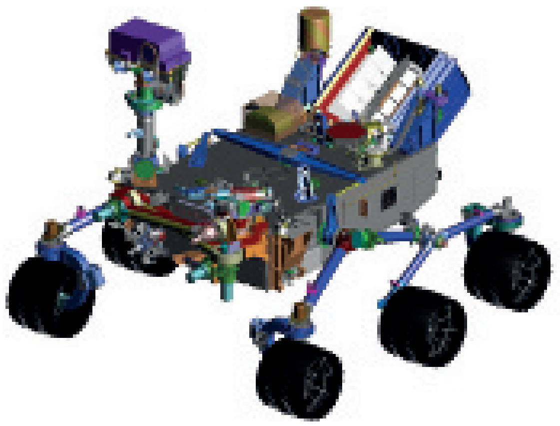


1 *Examples of ceramic-insulated, high-power piezo actuators. (Images courtesy of PI Ceramic)*

Multilayer actuators

The PICMA® piezo actuators (Figure 1) supplied by PI Ceramic are a good example. However, manufacturing these multilayer actuators with their long service life even under difficult environmental conditions, makes high demands.

First, the ceramic material, which is based on a special PZT ceramic (lead zirconate-lead titanate), is ground to make a slurry from which thin ceramic foils are cast. Next, electrodes are screen printed and the layers are laminated to stacks. The ceramic is compacted to remove the air trapped between the individual layers and then sintered together with the electrodes (cofiring technology) to create a monolithic block. This is protected against humidity and failures due to increased leakage current by an all-ceramic insulation layer. Due to this, the reliability and the lifetime are high. The monolithic design furthermore causes a high



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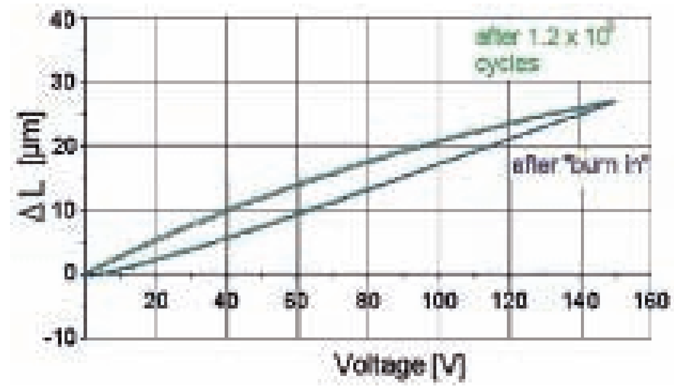

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resonance frequency, which makes these actuators ideally suited to highly dynamic applications. The ceramic is not flexible, the motion is fully based on solid-state effects. The dynamics of the reversal process are determined by the electrical contacting and the control electronics.

In space

The exclusive use of inorganic materials, not only for insulation, but also for the electrical contact, at the same time results in optimal conditions for use in ultra-high vacuum, as there is no degassing. The monolithic piezo ceramic stack achieves excellent reliability, even under extreme ambient conditions, and also extends the service life by several orders of magnitude. This also applies to applications under space conditions at a temperature close to absolute zero and under high vacuum. For example, the PICMA piezo actuators are used in the sample analyser system of the CheMin laboratory unit of the Curiosity Mars rover (Figure 2).

The CheMin instrument performs chemical and mineralogical analyses on Mars rocks. For supply with suitable rock samples, the rock powder first has to be sorted. To this end, the powder is shaken at various amplitudes and frequencies in the range from 0.9 to 2.2 kHz to achieve homogeneous particle sizes or separation according to density. This task is performed by the multilayer piezo actuators. They carry out the oscillations required in material selection and supply at a defined frequency.

In advance, the piezo actuators had to pass extensive qualification and testing prior to being allowed on board. In particular, their service life was tested – after all, a 2.5 billion dollar project could not fail due to an actuator. The extensive NASA performance and service life tests showed that 96% of original deflection was still achieved after 100 billion cycles (Figure 3).

2 *The CheMin spectrometer for chemical and mineralogical analyses in the Mars rover is equipped with piezo actuators. (Image courtesy of NASA)*

3 *Endurance test: no signs of drop in performance after several billion cycles.*

Crack prevention

To increase the service life of piezo actuators for such dynamic applications it is essential to reduce the probability of cracks. This is where the patented slot design of the PICMA® actuators comes into play, as it minimises the tensile load. The lateral slots prevent an increase in mechanical tensile stress in the stack and thus counteract the formation of uncontrolled cracks (Figure 4). Furthermore, the patented meander-shaped construction of the termination electrodes (see Fig. 5) ensures all internal electrodes have a stable electrical contact even at extreme dynamic loads.

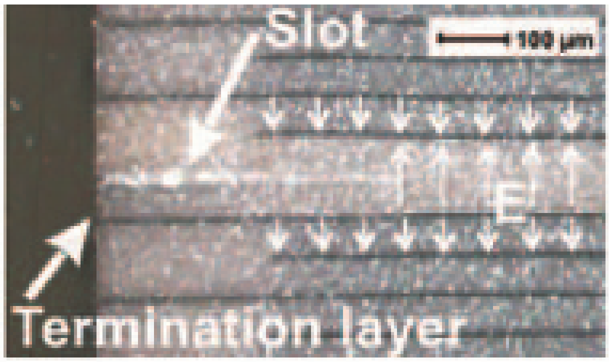
Humidity resistance

Humidity can negatively affect piezo actuators in low-dynamic nanopositioning applications. Very often, constant voltages are applied to the piezo actuator for prolonged periods. In the case of very high humidity and voltage values, then, as already mentioned above, this can lead to electro-chemical reactions which release hydrogen molecules which then destroy the ceramic composite by embrittlement. Due to their inorganic insulation, the PICMA actuators were able to deliver convincing results here; see the box on the next page.

Profile

PI (Physik Instrumente), with headquarters in Karlsruhe, Germany, is a leading manufacturer of nanopositioning systems with accuracies in the nanometer range. All key technologies are developed in-house, precision mechanics and electronics as well as position sensors. In the Netherlands, PI is represented by ALT (Applied Laser Technology), based in Best, near Eindhoven.

WWW.PI.WS WWW.ALT.NL



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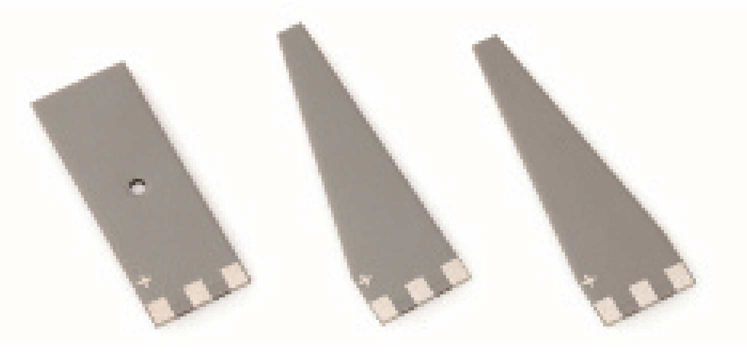

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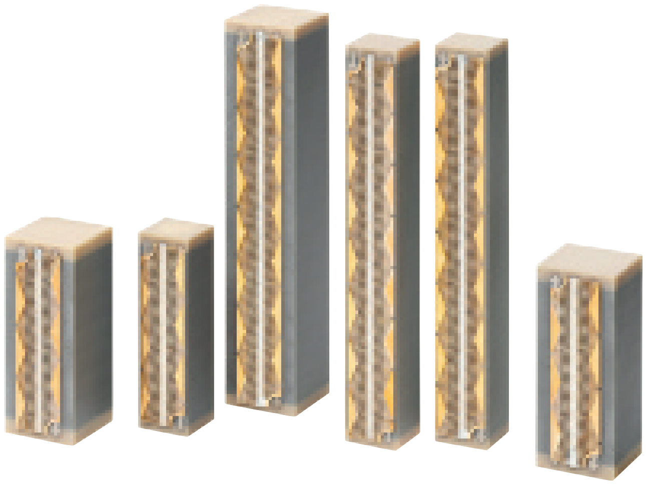

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4 *Patented design with lateral slots to avoid uncontrolled expansion of cracks during dynamic control.*

5 *Patented, meander-shaped external electrodes, providing stable electric contact even under extreme dynamic stresses.*

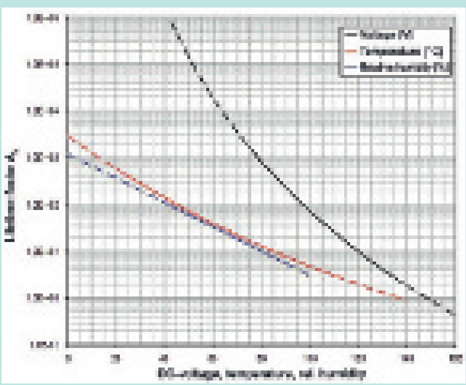
7 *Variable contour: flexibility in shape design with full ceramic encapsulation.*

Mean service life

A simple formula allows fast estimation of the mean service life in hours:

$$MTTF = A_U \cdot A_T \cdot A_F$$

Here, the factors A describe the effect on the mean time to failure *MTTF* of the determining powers: the operating voltage *U* (V), the temperature *T* (°C) and the humidity *F* (RH, in %); see Figure 6. This calculation can already be used in the design phase to optimise an application in terms of service life. For continuous operation at 100 V_{DC} with 75% humidity (RH) and an ambient temperature of 45 °C, a mean service life of 105,000 h, in other words, over 11 years, is calculated for the product.



6 *Service life under DC voltage conditions*

Positioning tasks in the manufacturing of semiconductors are a typical example of where resistance to humidity is important. High and constant offset voltages are usually employed here, for example, to keep wafers in a stable position during lithography and inspection. In this process, the clean rooms are artificially humidified to prevent electrostatic flashovers. Specifications between 50% and 65% relative humidity are therefore not uncommon. Cooling liquids in mechanical engineering applications are a further cause of increased ambient humidity.

Low operating voltage

Stable, reliable operation is also important in many other fields of application, such as white-light interferometry, which is often used for inspection tasks in LCD production for example, or for high-precision surface inspection in other manufacturing fields. The effect that the applied voltage has on the lifetime, is particularly important. At 80 V, for example, the service life to be expected is ten times higher than at 100 V. In contrast to most conventional actuators PICMA actuators achieve their nominal displacement at operating voltages significantly below 150 V. This property is achieved with particularly thin ceramic layers.

'Freeform'

Using modern production technologies, the multilayer actuators can be manufactured in virtually any shape. In doing so, all surfaces are encapsulated with an all-ceramic insulation (Figure 7). Various basic shapes are available, e.g. round or triangular cross-sections, but also insulated centre holes on benders, chips or stack actuators, allowing easier integration. The individual layers are then equipped with electrodes and laminated. As with standard actuators, the ceramic is then sintered together with the inner electrodes using the cofiring process. ■

THE DUTCH REPORT

Late last year, the American precision engineering community convened close to the 'technology temple' of MIT in Boston, Massachusetts – arguably one of the technological epicenters in the USA. In what is a strong tradition for the ASPE Annual Meeting, the organising committee had again succeeded in selecting an exquisite location at the Westin Boston Waterfront hotel. The Dutch (speaking) delegation has by now become another tradition, and like other years there was again a true sense of precision engineered 'brotherhood'.

DANNIS BROUWER, TON PEIJNENBURG, PIET VAN RENS AND GERRIT VAN DER STRAATEN

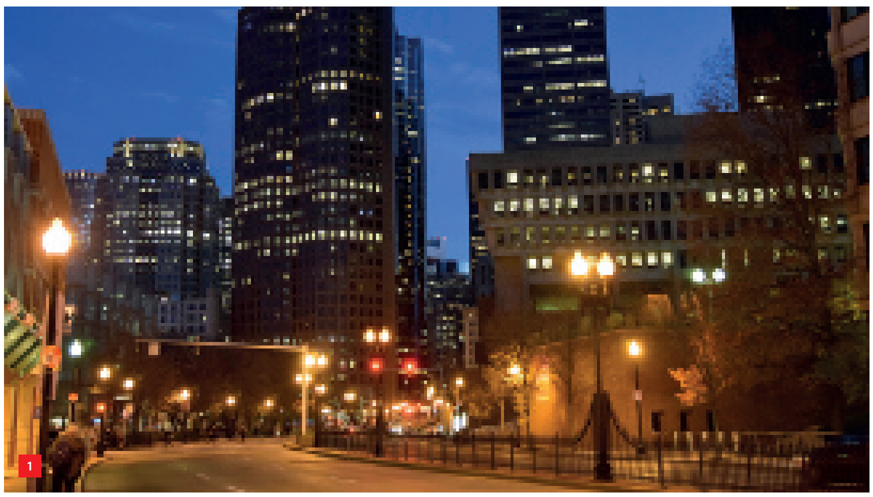
Workshops

Every year, the Annual Meeting of the American Society for Precision Engineering (ASPE) kicks off with tutorials on Sunday and Monday. The 2014 meeting in Boston, on 9-14 November, featured a nice selection of tutorials with significant Dutch contributions: Systems Approach to Thermal Modeling (Ruijl), Design Principles for Precision Mechanisms (Brouwer and Van Rens) and Ultra-High Vacuum Technology (Van der Heijden and Van der Straaten). Attendance was good, and so was feedback.

Closing the second day of tutorials was a keynote address by Dr Mark Johnson, who currently serves as the Director of the Advanced Manufacturing Office in the US Department of Energy under the Office of Energy Efficiency and Renewable Energy. He went into the impact of new manufacturing technologies on creating a fertile innovation environment for advanced manufacturing, enabling vigorous domestic development of new energy-efficient manufacturing processes and materials technologies to reduce the energy intensity and life-cycle energy consumption of manufactured products.

Technical presentations

A wide variety of topics was covered in the oral presentations at the 29th ASPE Annual Meeting. First was a series of presentations on the design of a new mass standard, by the principle of a Watt balance. The development is driven by NIST (National Institute of Standards and Technology), and creates a significant push in precision equipment development. Controlling a mechanism close to the limits of physical principles pushes equipment design. In the Netherlands, we've gotten used to high-tech companies like Philips and ASML demanding



1 Boston by night.
2 Impression of the "Design Principles for Precision Mechanisms" tutorial.

such technology push. In this case, such push is created by a US governmental body.

Another remarkable topic in the oral presentations, as well as on some posters, was the Chinese progress in development of advanced lithography tools. In the presentations, this progress was quite explicitly compared to products of the current technology leader in the field – products that many of the Dutch delegation knew quite well. The evidence provided a strong account of progress in Chinese precision engineering for high-end semiconductor equipment. In the poster sessions, Korean progress in development of equipment for display production showed a focus on mechanical bearings and ways to deal with friction to achieve increased positioning accuracy.

Taking a topical perspective, the 2014 conference again emphasised the importance of advanced measurement and control technologies for pushing the performance levels of equipment. In this respect, Van de Ridder (University of Twente) showed a nice concept for active vibration reduction of a Coriolis-type mass flow sensor. More accurate sensors as well as more elaborately designed control concepts are turned to where further optimisation of structures is no longer possible, or no longer economical. To specifically address the mechatronics-related issues with respect to precision, a combined topical meeting is planned on ‘precision control’ and ‘precision mechatronics’, to be held in Berkeley or Boston late April 2016.

After parties

Being an important aspect of the annual meeting, we spent pleasant hours with our international precision engineering friends, over lunch and dinner. The conference dinner was in the John F. Kennedy Presidential Library and Museum, which provided an immersive plunge back into the sixties, in addition to a nice variety of culinary specialities.

3 The ASPE Annual Meeting featured only one track, so most of the people could meet while attending the same track, creating a strong sense of joint experience, and helping to discuss the topics that were presented. (Photo courtesy of ASPE)

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ASPE community

At the ASPE society lunch, ASPE introduced the new concept of Technical Leadership Committees. Six distinct fields now have such a committee, managed by a senior member in combination with one of the six directors-at-large of the society. The following are the committees; please note that there is (again) a Dutch director-at-large.

- Precision Manufacturing: John Ziegert (University of North Carolina (UNC)), Alex Sohn (L-3 Communications)
- Metrology Systems: Vivek Badami (Zygo Corporation), Marcin Bauza (Carl Zeiss Industrial Metrology)
- Measurements and Characterization: Chris Evans (UNC), Richard Leach (University of Nottingham)
- Precision Design: Alex Slocum (Massachusetts Institute of Technology (MIT)), Mark Stocker (Cranfield Precision)
- Micro- and Nano-Technologies: Mark Schattenburg (MIT), Craig Forest (Georgia Institute of Technology)
- Controls and Mechatronics: Steve Ludwick (Aerotech), Dannis Brouwer (University of Twente)

Concluding

With even more than described in this short report, such as a student challenge competition at the conference, and an exhibition with 43 companies, the 2014 ASPE Annual Meeting has proven to be a worthwhile event. ■

INFORMATION
WWW.ASPE.NET

SAM 7.0

Dutch company ARTAS - Engineering Software has launched release 7.0 of the mechanism design software SAM. New features include derivation of user-defined results, constrained optimisation, easy calculation of bearing forces in moving joints, new transformation & grouping commands and a new licensing system.

EDITORIAL NOTE

This article was based on a press release by ARTAS - Engineering Software.

www.artas.nl

The mechanism design software SAM is a popular tool for everybody involved in the conceptual design, motion/force analysis and optimisation of mechanisms as applied in equipment, the automotive industry (for example roof mechanisms of convertibles), and medical, lifestyle or domestic products.

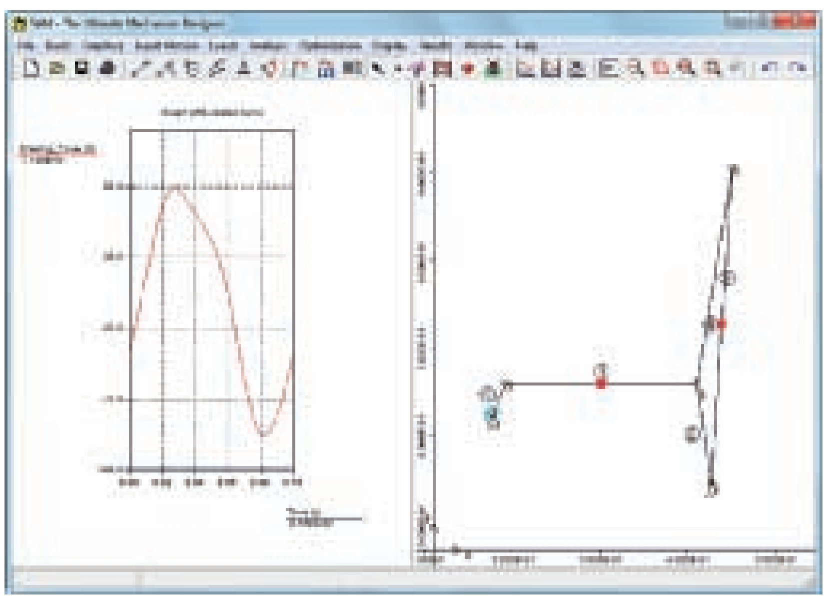
Due to its intuitive user interface and ease of use, the software is popular amongst designers and engineers who are only involved in mechanism design on an occasional basis and have to cope with lots of other design issues as well. On the other hand, specialist users can benefit from the advanced optimisation techniques available to further enhance a certain design. The software is also widely used by professors and students all over the world.

Major enhancements

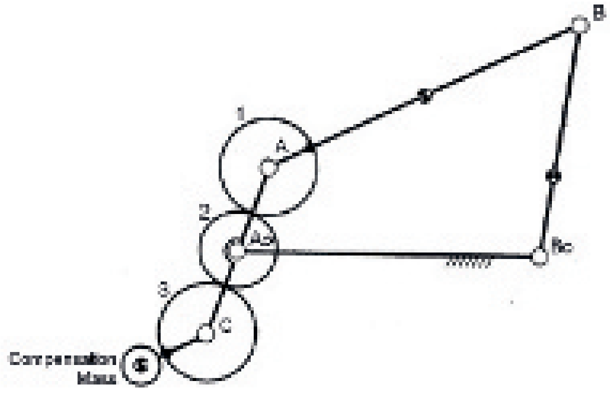
- User-defined results (only in SAM Professional)
  A sophisticated formula parser offers the possibility to post-process simulation results in multiple ways to derive user-defined results.
- Constrained optimisation (only in SAM Professional)
  The feature of user-defined results opens the path to perform constrained optimisation by adding the constraint condition as a penalty function to the original function that is being optimised. This opens up completely new possibilities during the optimisation.
- Easy calculation of bearing forces in moving joints
  The calculation of bearing forces in joints is now equally easy for fixed and for moving joints. In previous versions of SAM the calculation of bearing forces in moving joints required manual steps, which have now been eliminated.
- New transformation & grouping commands
  New transformation (mirror, translation, rotation, ...) and grouping commands have been added that allow the user to easily modify elements/mechanisms, but also graphical items.
- New licensing system
  The new licensing system now also supports floating licenses next to the existing node-locked licenses. The duration of both license types can be perpetual or annual. For education purposes, a new classroom-kit has been defined consisting of floating licenses for the institute, a node-locked license for the trainer and annual licenses for the students.

Example: Reduction of shaking force in fast transfer arm mechanism

In high-speed machines, mass balancing of the moving links brings about a reduction of the variable dynamic loads on the frame and, as a result, a reduction of vibrations. The reduction of shaking forces and torques improves the accuracy of the machine, but also reduces noise, wear and fatigue.



1 *Plot of the shaking force as a function of time and the transfer arm.*



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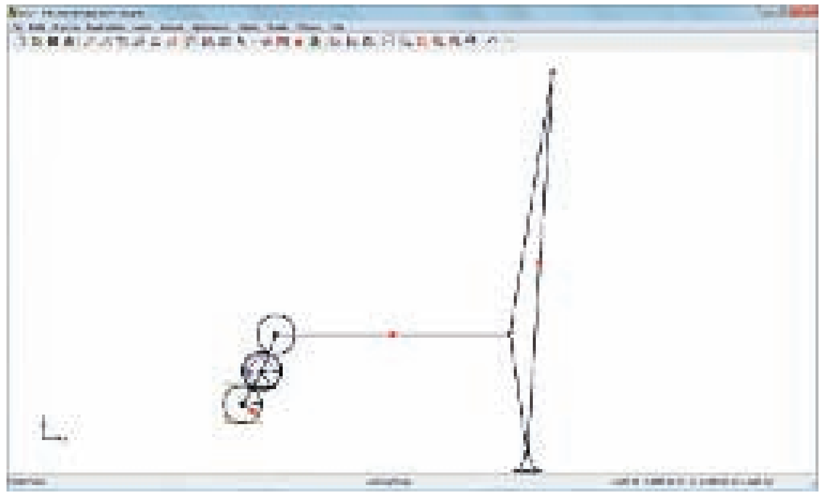

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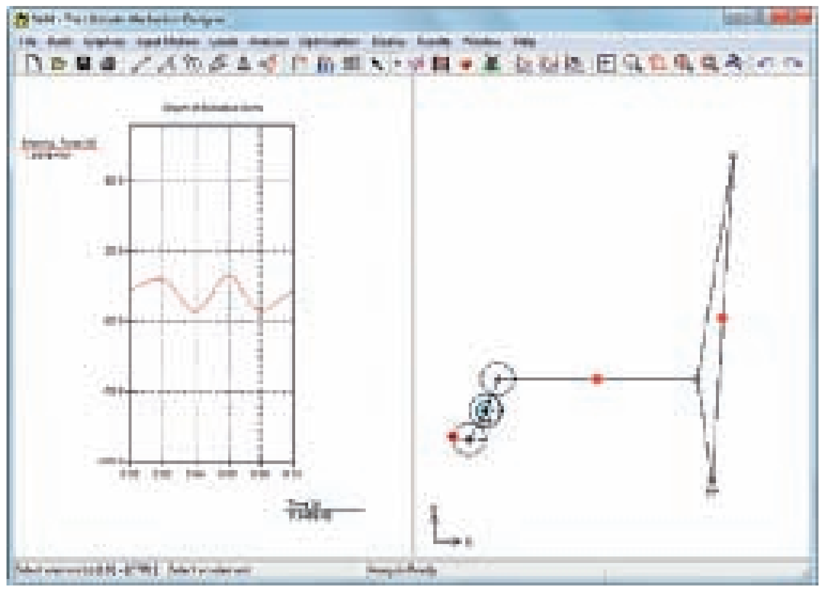

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2 *Compensation concept suggested in [1] which involves a compensation mass and three gears, which are mounted on the crank. Gear 1 is connected to the coupler link and meshes with gear 2, which is mounted on the rotation axis of the crank. Gear 3 is connected to the counterweight and also meshes with gear 2.*

3 *Transfer arm mechanism with compensation mechanism and randomly chosen position of the compensation mass.*

4 *Transfer arm with optimised compensation mechanism.*

Different approaches and solutions have been developed and documented. However, these often involve complex mathematics and, for a practicing engineer confronted with such a design challenge (as one of the many challenges that need to be tackled), it is not an easy task. That is where a practical tool like SAM comes in.

In this example we will look at the shaking forces introduced by a fast-moving transfer arm mechanism, similar to the one previously used in certain die bonders to transfer the die from the wafer to the lead frame prior to the bonding step. In this example realistic masses and aggressive processing times are assumed.

Figure 1 shows the original transfer arm mechanism and the combined shaking force as a function of time. The maximum force amounts to about 93 N.

In order to demonstrate the optimisation capabilities of SAM, one of the many concepts found in literature (Figure 2) is integrated into the transfer arm model (Figure 3) and its optimum parameters are determined.

In the next step, the optimisation task is defined as finding the position and value of the compensation mass that minimises the maximum positive or negative value of the force during a full revolution of the crank. The value for the compensation mass was limited to a range of 0-0.5 kg, whereas the area for the location of the compensation mass was a square with the length of the sides equal to the diameter of gear 3. In this case an unconstrained optimisation was performed, but additional constraints could have been added as well.

Figure 4 shows the result of the optimisation process, which was based on a combination of an evolutionary algorithm to explore the solution space and the Simplex method to perform local optimisation of the best results of the exploration phase. As one can see, the combined shaking forces are reduced from 93 N to about 12.5 N. ■

REFERENCE

[1] V.H. Arakelian and M. R. Smith, "Shaking Force and Shaking Moment Balancing of Mechanisms: A Historical Review With New Examples", *ASME Journal of Mechanical Design*, vol. 127 (2), pp. 334–339, 2005.

Motorsport to Automotive

An important part of vehicle development is Driver-in-the-Loop testing and there is an increasing need to start this level of testing earlier in the process, often before a representative prototype is available. To meet this need a wide range of driving simulators are available with the most sophisticated systems now able to support detailed vehicle engineering.

The vehicle model is a critical component in these systems and the capability of the platform to support vehicle engineering activities is determined by the fidelity of this model. Using Modelica modelling language, Claytex can produce high fidelity vehicle models that include every vehicle system consisting of MultiBody mechanics, electrical, thermal, fluids and control systems. Dymola, a Modelica modelling and simulation tool, is used to transform these models into efficient simulation code that can run in real-time and be coupled to the Driver-In-the-Loop simulation platform.

These technologies have been developed in motorsport and applied in Formula 1 and NASCAR for many years enabling the teams to evaluate detailed geometry changes or new technologies before arriving at the race track. The same technology is now being applied for road cars to enable a wide range of engineering activities including handling, active safety systems, ride, NVH and control system integrity.

Modelica can be used to create MultiBody vehicle dynamics models that can be run in

real-time in a driver-in-the-loop simulator. Modelica allows to easily include the electric motors, power electronics and energy storage devices associated with a hybrid or electric powertrain and to include the thermal management of these systems as part of the simulation.

Meet with Claytex at High-Tech Systems Exhibition on 25th & 26th March, Stand 9, to find out more. Claytex will be presenting at the Thermo Mechatronics Session on Thursday 26th March at 16:00. 'Investigating the effect of gearbox preconditioning on vehicle efficiency'

NETWORKING & PARTNERSHIP IN PRECISION ENGINEERING

The European Society for Precision Engineering & Nanotechnology, euspen, recognises that extensive research and innovation in precision, micro, and nano manufacturing across Europe demands that efforts are focussed on educational and networking activities to stimulate growth and meet overall market requirements. Euspen wants to lead delivery of such educational and networking requirements, disseminating information relating to high-quality innovation, and sharing knowledge within the community, embracing OEMs, technology and service providers, research bodies, and academics.

DISHI PHILLIPS

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Introduction

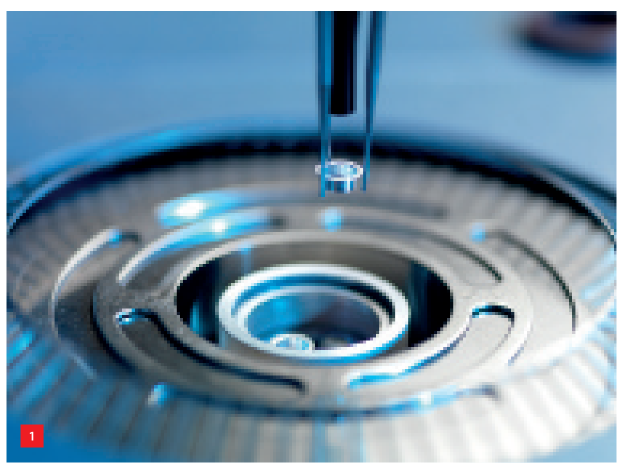
There is no doubt that the area of precision engineering is fast moving and dynamic, and that for OEMs working on projects on the micro- and nano-scale (and for suppliers of technology and service supplies to the sector), there are numerous twists and turns to navigate to ensure optimal commercial success.

The areas of micro and nano manufacturing are pretty unique. Ground-breaking technological developments seem to occur every other week, and for some, it is tempting always to focus on what's next rather than the potential of what is available now.

With alarming frequency, what was impossible yesterday is becoming possible today. This presents massive opportunities for OEMs that are looking to innovate and produce more and more precise products and components. But it can also become confusing, as it can often seem as if today's 'go-to' technology solution will soon be replaced by something quicker, more cost-effective, or more precise. There is a need for access to impartial, practical, and high-quality information, and the opportunity to network with peers working in the precision engineering and nanotechnology (see Figure 1) niche.

The miniaturisation drive

In the early days of the commercialisation of micro manufacturing technologies, there was a lot of discussion



1 *Differential Scanning Calorimetry used to analyse how a material's heat capacity is changed by temperature with applications in the nanotechnology sector. (Photo courtesy of National Physical Laboratory (NPL))*

2 *An array of micro metal parts with extremely tight tolerances and complex geometries. (Photo courtesy of NPL)*

about what constituted 'micro' manufacturing or precision engineering (see Figure 2). There was (and indeed still is) a recognised continuum from small to precision, micro, and then nano-scale components and features. In general, it is fair to say that with every week that passes, OEMs are able to manufacture – often at volume – parts that only recently seemed impossibly small, and increasingly we are beginning to discuss parts and features in terms of nanometers instead of microns. We are forever moving down the size continuum, and today's 'micro' parts were yesterday's pipe dreams.

Real 'nano' manufacturing is unlike what we all understand as conventional manufacturing, and involves the self-assembly of parts and components at the molecular scale. This being a discipline still very much in its infancy, and involving manipulation and interaction of chemicals, building materials atom by atom.

Micro manufacturing or precision engineering, on the other hand, (often incorporating nano-scale features) essentially involves the manufacture of products, components, and features in a conventional way. Utilising variations and evolutions of well-known 'traditional' machining, moulding, processing and automation technologies that over time have become more and more precise.

Across industry in general, the move in terms of product and component design towards miniaturisation is intensifying. For many sectors (such as aerospace and automotive) it is driven by the desire to use less material and optimise weight savings. In the medical area, miniaturisation is driven by the desire to create products that allow for ease of implantation or that facilitate new surgical procedures or treatments with minimal invasiveness. For all sectors, however, miniaturisation of components or features on components drives innovation, increases product functionality, and will reduce costs.

Of course, there is a trade-off between miniaturisation and the actual function of products. Smaller is not always better and there are limits to the extent to which products or features can be reduced in size and still produce optimal functional outcomes. A few argue that there is a danger in some instances that the oft quoted design mantra that "form should follow function" can become lost as product designers continually strive for miniaturisation. In general terms, design engineers are forever pushing the boundaries of increased precision and reduced size in balance with part functionality and end-user requirements.

Precision engineering's best kept secret

As the demand from OEMs across a variety of industry sectors grows in the area of precision engineering, a burgeoning number of technology and service providers are helping to fulfil their requirements. There is an active, growing, dynamic, and interested community of professionals in the precision engineering sector, and best results are achieved when this community networks and exchanges information.

OEMs and technology providers are not two discrete groups in the precision engineering field. It is vital for OEMs to tap into networks, events, and information resources in order to understand what opportunities exist, and which technologies and service providers to engage and partner with. The word partnership is used advisedly. Stimulating partnerships and relationships are the lifeblood of future commercial successes. Very often in this increasingly important area of industry, optimal results occur when OEMs and technology providers link arms. For the OEM, engaging a technology provider early in the design cycle ensures that products are designed in a way that allows them to be manufactured, and the requirement for multiple, costly and time-consuming re-iterations is reduced.

For the technology supplier, partnerships with OEMs are often vital to evolve and optimise solutions, and there is a pragmatic understanding that inducing OEMs to become early adopters is perhaps the only way to ensure that

3

3 *Impressions of euspen's 14th Annual Conference and Exhibition, held in Dubrovnik, Croatia, on 2-6 June 2014.*

technologies are produced that best service industry requirements.

Since 1998, euspen

Euspen has been working in the dynamic micro manufacturing niche for years, and is therefore aware of the potentials to exploit and the pitfalls to avoid, as well as areas of innovation that are dawning and which provide huge potential for product development and market exploitation. What is obvious to all involved in the precision, micro, and nano manufacturing arena today is that recent ground-breaking manufacturing solutions offer the potential right now for efficient and cost-effective mass manufacture. Technologies that yesterday were being proved and tested, and were seen at best as prototyping technologies, are now scalable and delivering millions of parts a year.

Euspen is an institution that is geared up to help OEMs and technology providers alike to take advantage of the opportunities that exist today, and raise awareness of the 'new kids on the block' that will continue to revolutionise and change what OEMs make and how they manufacture.

Euspen has been actively pioneering advancements in precision engineering and nanotechnology since 1998, and its roots were planted when a group of leading European industrialists and academics came together with a shared desire to establish a networking forum for the already important (but nascent) precision engineering and nanotechnology community. Their aim was to establish a body that worked alongside and complemented societies in the United States and Japan that were already working in the sector.

Aims and plans

Euspen's mission is to assist in the continual development and advancement of the European precision engineering and nanotechnology sectors. Today begins a huge push from euspen to attract more members from OEMs, technology and service providers, academics, and researchers alike. As already noted, it is the cross-fertilisation of ideas, and the drawing together of all professionals in the sector that will ensure success.

So far, euspen has attracted over 4,000 experts in the precision and nanotechnology area, and this makes it already one of the most influential global players in precision, micro, and nano manufacturing. As an industry body, euspen is fairly unique in that its membership base includes research institutes, OEMs, and technology providers alike. This ensures the most fertile environment for the sharing of views and research advances that progress the advancement of precision engineering techniques and their optimal commercial use.

All involved in rapidly changing and dynamic sectors such as the precision engineering industry must grasp any and all opportunities to gain competitive edge. Euspen recognises this, and offers its members not just 365 days a year networking opportunities with the cream of professionals working in the field but also hosts a series of events and meetings, and produces a range of peer-reviewed publications designed to stimulate innovation and excellence.

Euspen's Annual Conference and Exhibition provides a global forum for the precision engineering and nano-technology sector (see Figure 3). The 15th edition is to be held in Leuven, Belgium, on 1-5 June 2015. This event is the focus for the precision engineering community and brings together a plethora of experts presenting key-note papers and seminars, and an impressive array of exhibitors.

Euspen is also recognised as a significant driver in the advancement of precision engineering in education. In addition to supporting young technologists through scholarships, bursaries, a European certification programme (in collaboration with DSPE, see page 4; Ed. note) and dedicated training events, in 2015 the Society is running the euspen Challenge 2015, an international competition to identify students from across Europe with the potential to be future leaders in the field of precision engineering and nanotechnology. Heats run from early 2015 and the focus of this initiative will be 7-9 July when the winning students will come together in Stockholm to compete for the prize of euspen Challenge Winner.

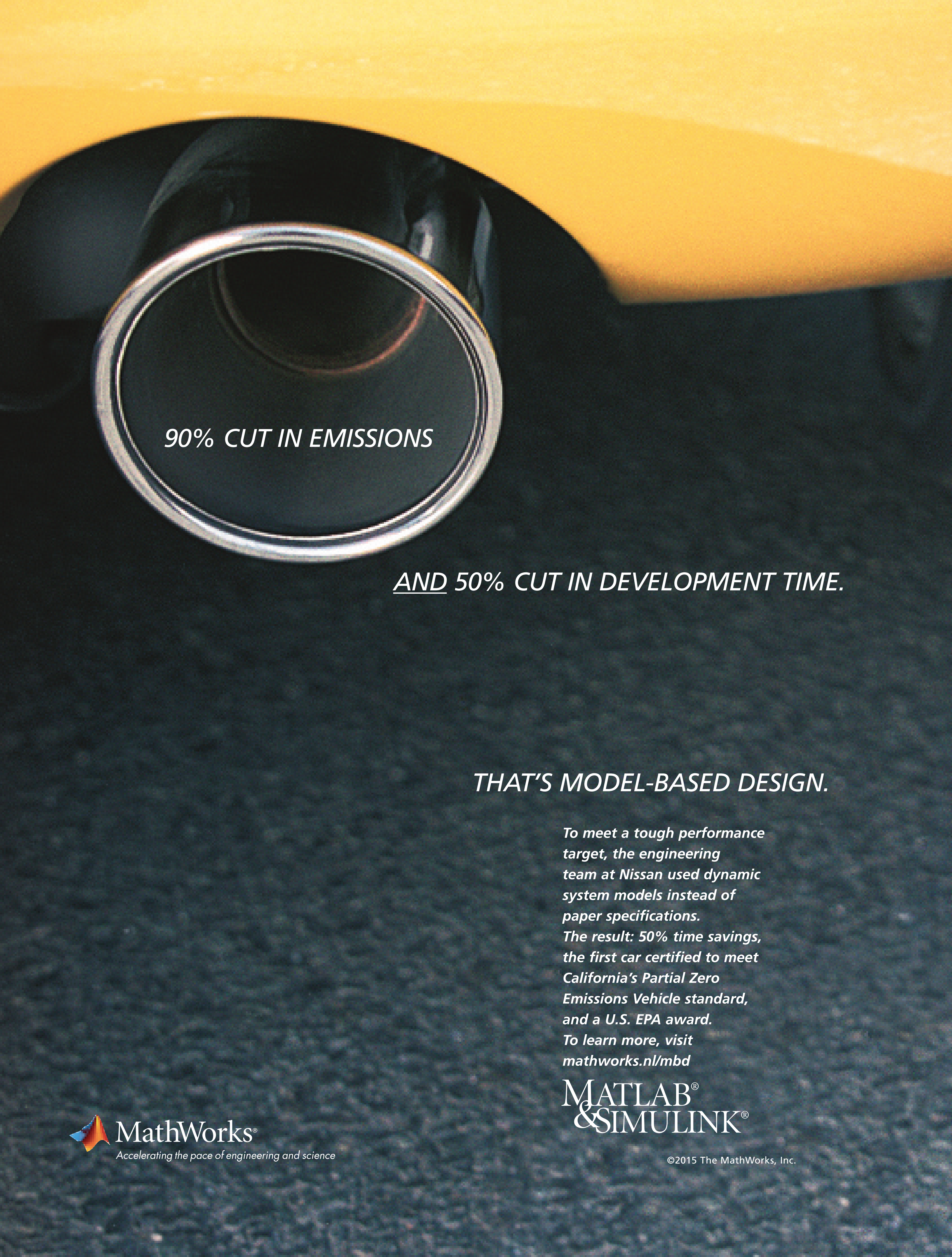
Euspen representation and membership

As it stands, euspen already has representation in 32 countries, with its focus on best-in-class machining, processing, and metrology technology solutions, and has an impressive array of members and sponsors including among many others technology and service providers like Aerotech (precision motion control and positioning systems), Agilent (precision measurement), ASML (lithography systems for the semiconductor industry), Bosch (leading global supplier of technology and services), Cranfield Precision (high-precision machine tools), Heidenhain (equipment for demanding positioning tasks), Hexagon Metrology (industrial metrology applications), IBS Precision Engineering (intelligent measurement solutions), Lion Precision (precision measurement), Precitech (ultra-precision turning machines), and Renishaw (precision metrology and spectroscopy solutions).

Summary

Key to success in all areas of precision engineering and nanotechnology is industrial partnerships. For OEMs it is vital that technology and service suppliers are not seen as remote players, but rather project partners that should be embraced in product development programmes at the earliest possible point in the design-to-market process. Precision engineering requires that the relationship between OEM and technology specialist is a true partnership, but often run differently from a traditional OEM/supplier relationship. In precision engineering, most of the mission-critical issues occur at the design and prototyping stage of product development. A true partnership will ensure faster time-to-market with more efficient and lower cost products.

Similarly, 'partnerships' between technologists, academics, and OEMs ensure success in R&D initiatives and the optimisation of the technology solutions that keep pushing the boundaries of what is possible in precision engineering and nanotechnology. Euspen membership must surely be considered by anyone already involved in or planning to move into this exciting, dynamic, and innovative area of industry. ■



Get smart at High-Tech Systems 2015

Smart Industry, it is by far the hottest topic in industrial automation. The fourth industrial revolution is characterized by the ongoing digitalization of factories. Companies are challenged to adapt to this new reality. The Dutch industry can profit from this new playing field by accelerating at a high pace. In order to win, quick action is needed. Politicians and entrepreneurs that don't pay attention, will miss the boat. The coming twenty years the economy of many countries will change more than the last half century.

Kick-started by the German Industrie 4.0, the Dutch industry presented an extensive and ambitious vision document at Hannover Messe 2014. Since then Team Smart Industry, chaired by FME director Ineke Dezentjé Hamming, is working on the implementation of the initiative, centred around three action lines: capitalising on existing knowledge, accelerating in Fieldlabs and strengthening the foundation. The Fieldlabs are the experimental gardens of Smart Industry and ensure the birth of ecosystems where the necessary close cooperation in the value chain will develop naturally.

If the Netherlands acquire a leading role on a global level, Smart Industry could be the driving force behind a strong growth in jobs. So don't fall behind and ride the Smart Industry wave. At High-Tech Systems you can hear inspiring ideas of renowned policy makers and real-life experiences of entrepreneurs that are already well under way with new technologies and business models.

Alexander Pil
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Free entrance
By preregistration until 23 March 2015

Gold sponsor SEGULA TECHNOLOGIES

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Reception sponsor THE HIGH TECH INSTITUTE

Free entrance

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Organisation

High-Tech Systems 2015 is organised by Techwatch, publisher of Mechatronica&Machinebouw and Bits&Chips.

Information

Presentation programme: Alexander Pil, *alexander@techwatch.nl* or +31 24 3504580
Other questions: *events@techwatch.nl* or +31 24 3505544.

Conference programme

Wednesday 25 March

	Adaptive robotics (In cooperation with Brabant Development Agency BOM)	High-tech materials (In cooperation with ION)
9:30	Sparc's contribution to innovation by spreading robotics technologies Uwe Haass, Eurobotics	
10:00		
10:30	Break	
11:30	Web-enabled and experience-based cognitive robots performing everyday manipulation tasks Hagen Langer, University Bremen	3D metal printing, from process development to large volume manufacturing of pure Tungsten Harry Kleijnen, Philips
12:00	Laser coating removal robot: a breakthrough in paint stripping technology Peter Boeijink, LCR Systems	Advanced ceramic materials in high-temperature Rapid Thermal Processing system Ernst Granneman, Levitech
12:30	Lunch	
14:00	The need for an integral approach for smart and flexible automation Bas van der Hoek, Philips Consumer Lifestyle	Engineering with carbonfiber composites Bas Nijpels, Refitech
14:30	How to do business in medical robotics Benno Lansdorp, Demcon	Performance materials in 2D and 3D digital printing Otto Salomons, Océ
15:00	Break	
16:00	Market survey on robotics: business opportunities for Brainport Marcel Grooten, Tom & Ruben Kolfschoten, Bom	Anodic oxidation improves high-tech components Henk Schreuder, Coatinc
16:30		Assembly – disassembly: save the costs of damaging (machine) parts Wim Geurts, Oerlikon

Conference programme

Thursday 26 March

	High-level supply chain	Smart Industry
9:30	Creative supply chains required in a changing global business environment Edward Voncken, KMWE & Menno Wolf, Fokker	Smart Industry - why and how Arnold Stokking, TNO
10:30	Break	
11:30	Make, buy or ally: Global strategy for a flexible supply chain Edgar Beers, Vanderlande	Transparency crucial for Smart Industry Lucas Wintjes, Bosch Rexroth
12:00	Accepting or avoiding manufacturing risks? Dick van Hees, ASML	Smart production of high-precision customized components Marco Kusters, Veco
12:30	Lunch	
14:00	Total cost of ownership meets QLTC Max van den Berg, Festo	Smart Industry hugh potential, also for SMEs André van der Leest, Teqnow
14:30	Product architecture + supply chain design = improved business performance Jeroen Vos, Asintik	The smart plugin company Carel van Sorgen, 24/7 Tailor Steel
15:00	Break	
16:00	How costing software will drive change in supply chains Huub Ehlhardt, Philips	Optimizing logistic performance with AGV's Marc Meijs, Prodrive
16:30	Challenges in evolving high tech supply chains Mathé van Knippenberg, Knippenberg Consultancy	The digital factory: smart networked high-tech supply chain John Blankendaal, Brainport Industries

HIGH-TECH SYSTEMS

Conference and exhibition on mechatronics and system engineering

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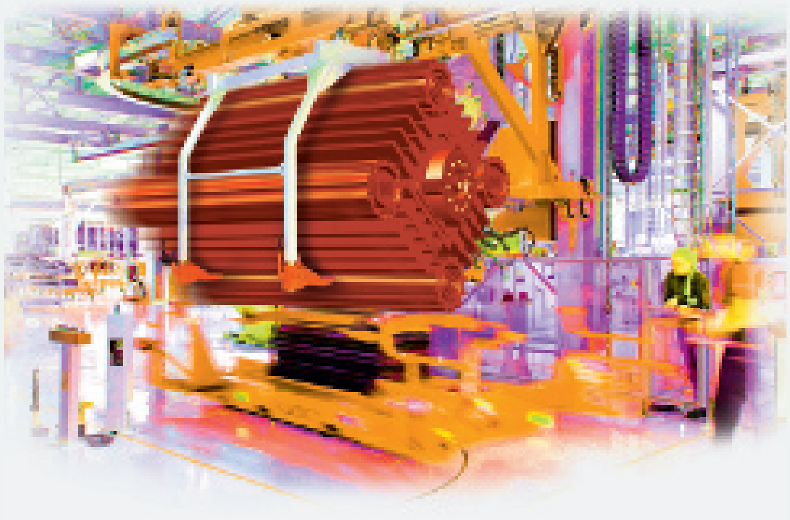


Opto mechatronics

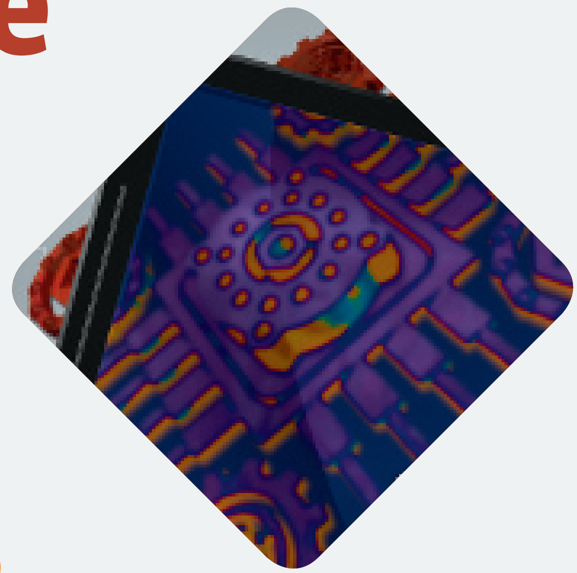
9:30	Extreme UV light generation – high power laser technology at the physical limit **Volker Jacobsen, Trumpf**
10:00	Design and engineering of a stepper lens **Gerard van den Eijkel, Focal**
10:30	Break
11:30	Optics and photonics essential to manufacturing **Hugo Thienpont, VU Brussel**
12:00	An enlightening view on optical assembly **Markjan Vermeer, IMS**
12:30	Lunch
14:00	Integrating a white-light-interferometer in a vision measurement metrology system **Han Haitjema, Mitutoyo**
14:30	Bringing traceable nanometrology to the production line **Marijn van Veghel, VSL**
15:00	Break
16:00	Spatial filtering and laser beam control in a matrix-grooving machine **Guido Knippels, ASM Alsi**
16:30	Meta-Instrument for super-resolution imaging **Hamed Sadeghian, TNO**

In cooperation with SEGULA TECHNOLOGIES

	Medical systems	Thermo mechatronics
9:30		Advanced thermal control **Marco Koevoets, ASML**
10:30	Break	Break
11:30	Minimally invasive techniques - recent developments in instruments, training and workflow **Jenny Dankelman, TU Delft**	PCM-shielding of heat sources for reduction of thermal errors **Marc Schalles, TU Ilmenau**
12:00	Development of a medical ventilator module for OEMs **Geert van Dijk, Macawi**	Model-based design in mechatronic thermal and flow systems **Patrick Smulders, Segula**
12:30	Lunch	Lunch
14:00	Rewalk – Rehabilitation, mobility and more?? **John Frijters, Rewalk**	Millikelvin thermal controllers **Paul Morantz, Cranfield**
14:30	Cassini: The new playground for shaping the 21st century intraocular lenses **Dirk De Brouwere, I-Optics**	Interferometric CTE measurements of materials and joints and associated temperature metrology **Jens Flügge, PTB**
15:00	Break	Break
16:00	Trajectory control for a medical robot **Rob Gielen, Philips**	Investigating the effect of gearbox preconditioning on vehicle efficiency **Alessandro Picarelli, Claytex**
16:30	Additive manufacturing in the healthcare industry **Sven Hermans, Materialise**	Model-based control of a fluid stream heater **Rob van Gils, Philips**

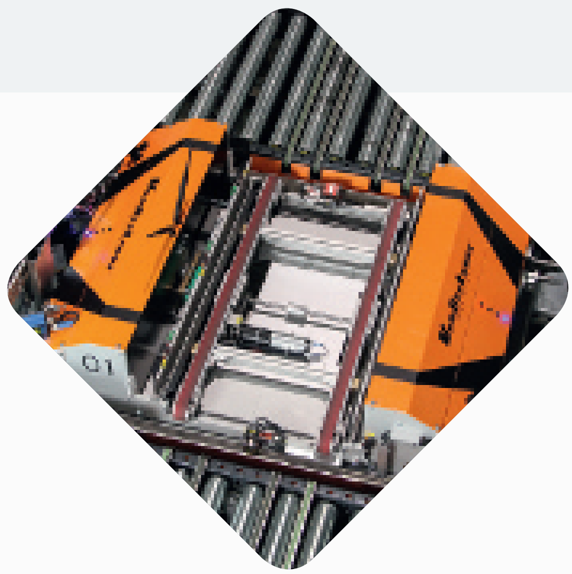
Subject to change

Conference highlights



Thermo mechatronics
Learn to precisely manage thermal fluctuations

Smart Industry
Vision, Fieldlabs and real-life experiences



Supply chain management
The choices of Vanderlande: make, buy or ally?

Advanced robotics
How can we make money with robots? Join the discussion

Optics
Lasers Trumpf power ASML's euv source

Macawi
The ups and downs of a starter in healthcare

GAS BEARING WORKSHOP

At the initiative of VDE/VDI GMM (Microelectronics, Microsystems and Precision Engineering Society), DSPE and the Dutch Consulate-General in Düsseldorf (Germany), a Gas Bearing Workshop will be organised on Tuesday 14 April 2015 in Düsseldorf.

The Gas Bearing Workshop will be held at the Industrie Club Düsseldorf.

Gas bearings are important components or integral technology of most advanced precision instruments and machines. The workshop is targeted at engineers, scientists, system architects and users of gas bearings to share the state of the art in research and industry regarding new developments and (new) applications. The subject will be presented from different angles by experienced manufacturers and scientists. Topics include linear, rotating and planar bearings, static and dynamic behaviour, positioning in/with gas bearings, and system integration.

Speakers are from companies such as Eitzenberger, Aerolas, LT Ultra, Leuven Air Bearings and Philips Innovation Services, Delft University of Technology and the Fraunhofer-Institut für Angewandte Optik und Feinmechanik. There will be extensive opportunity to get in touch with colleagues and experts from various countries. The initiators of the workshop intend to establish a forum for the gas bearing community. ■

WWW.DSPE.NL/CENTRAAL/EVENTS/GAS-BEARING-WORKSHOP

"Go visit the European Robotics Forum 2015"

As an enabler of innovation in industry and society, robotics is a spearhead of European innovation policy in the Horizon 2020 programme. To date, however, the Dutch are underrepresented in the European arena, for example in euRobotics, the Brussels-based international non-profit association for all stakeholders in European robotics. "To keep up with global developments and progress in robotics, the Dutch robotics community should strengthen its international position," says contact Henk Kiela, Professor in Applied Mechatronics (including Robotics) at Fontys Hogescholen. An excellent opportunity is provided by the European Robotics Forum 2015 on 11-13 March 2015 in Vienna, Austria.

The European Robotics Forum is a meeting point for at least 350 scientists, companies and robotics officials from the European Commission. The program provides an opportunity for the companies and researchers to meet and interact in workshops and seminars in order to expand their networks, gather the latest relevant information and build new businesses and alliances. Kiela: "So, go visit the European Robotics Forum 2015."

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YOUNG PRECISION NETWORK VISIT TO ASSEMBLÉON

Assembléon produces machines for placing components (mostly surface mount devices like chips and resistors) on printed circuit boards. Since the last visit by DSPE's Young Precision Network (YPN) in 2010, Assembléon went through some difficult times, but things are improving rapidly and it really showed during the recent YPN visit at the end of November 2014.

Jeroen de Groot, CEO, welcomed the YPN party and gave a presentation on Assembléon's market, strategy and forecast. The main driver is a change of strategy away from the cost-driven market of bulk production to the more specs-driven market of advanced packaging. This has meant that Assembléon stopped its sales activities for several machines that were targeted towards the bulk-production market. As a result, turnover reduced from €125 million to €75 million. However, profits went up as Assembléon now has a strong focus on its core competences.

Several new developments were also presented. The first was a programme to improve machine accuracy to 10 micrometers to allow on-machine flip-chip bonding. Assembléon believes this could be a great opportunity for its machines in the future. To make this step, several on-machine measurements are performed. These are used in a model of the machine to measure the contributions of each error source to the total placement accuracy (in a Monte-Carlo simulation). This provides a structured approach to improving machine performance. Some improvements were discussed, including compensation for in-machine acceleration forces.

■ *Impression of the factory tour during the YPN visit to Assembléon.*

In a second presentation a new z-phi gripper was discussed. In the final design, the linear actuators are integrated into the air bearings to create a very compact and lightweight structure. By using different diameters in the air bearing, a gravity compensation mechanism is elegantly integrated in the design. Finally, a new low-force nozzle was presented. Its design features a nice balancing act between the minimum desired placement force (determining the preload force on the nozzle) and the nozzle stability when holding relatively large components under high acceleration forces. After the presentations, there was a tour through the factory and testing laboratory with a demonstration of a real-speed assembly using Assembléon's iFlex machine.

YPN thanks Sjef van Gastel, Jeroen de Groot, Gerry Lutters, Rene Bouman and Roy Brewel, all of Assembléon, for organising the visit. YPN is part of DSPE and aims to promote precision technology among students and young professionals. Participation is free and without obligation. ■

(report by Edwin Bos)

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Editorial note

After this report had been made up, Kulicke and Soffa Industries, the Singapore-based designer and manufacturer of semiconductor and LED assembly equipment, last month announced it had acquired Assembléon to expand its presence in advanced packaging, automotive and industrial segments.

CPE COURSE CALENDAR

COURSE (content partner)	CPE points	Provider	Starting date (location, if not Eindhoven)
BASIC			
Mechatronic System Design - part 1 (MA)	5	HTI	13 April 2015
Mechatronic System Design - part 2 (MA)	5	HTI	20 April 2015
Construction Principles	3	MC	8 April 2015 19 May 2015 (Utrecht)
System Architecting (Sioux)	5	HTI	9 March 2015
Design Principles Basic (SSvA)	5	HTI	to be planned (Autumn 2015)
Motion Control Tuning (MA)	6	HTI	8 April 2015
DEEPENING			
Metrology and Calibration of Mechatronic Systems (MA)	3	HTI	24 November 2015
Actuation and Power Electronics (MA)	3	HTI	16 March 2015
Thermal Effects in Mechatronic Systems (MA)	3	HTI	29 June 2015
Summer school Opto-Mechatronics (DSPE/MA)	5	HTI	22 June 2015
Dynamics and Modelling (MA)	3	HTI	7 December 2015
Summer School Manufacturability	5	LiS	17 August 2015
SPECIFIC			
Applied Optics (T2Prof)	6.5	HTI	3 November 2015
Applied Optics	6.5	MC	5 March 2015
Machine Vision for Mechatronic Systems (MA)	2	HTI	19 March 2015
Electronics for Non-Electronic Engineers (T2Prof)	10	HTI	to be planned
Modern Optics for Optical Designers (T2Prof)	10	HTI	to be planned
Tribology	4	MC	21 April 2015 3 November 2015 (Utrecht)
Introduction in Ultra High and Ultra Clean Vacuum (SSvA)	4	HTI	to be planned
Experimental Techniques in Mechatronics (MA)	3	HTI	1 April 2015
Design for Ultra High and Ultra Clean Vacuum (SSvA)	3	HTI	to be planned
Advanced Motion Control (MA)	5	HTI	5 October 2015
Iterative Learning Control (MA)	2	HTI	to be planned
Advanced Mechatronic System Design (MA)	6	HTI	3 July 2015
Finite Element Method	5	ENG	21 May 2015

DSPE Certification Program

Precision engineers with a Bachelor's or Master's degree and with 2-10 years of work experience can earn certification points by following selected courses. Once participants have earned a total of 45 points (one point per course day) within a period of five years, they will be certified. The CPE certificate (Certified Precision Engineer) is an industrial standard for professional recognition and acknowledgement of precision engineering-related knowledge and skills. The certificate holder's details will be entered into the international Register of Certified Precision Engineers.

WWW.DSPE.NL/EDUCATION/LIST-OF-CERTIFIED-COURSES

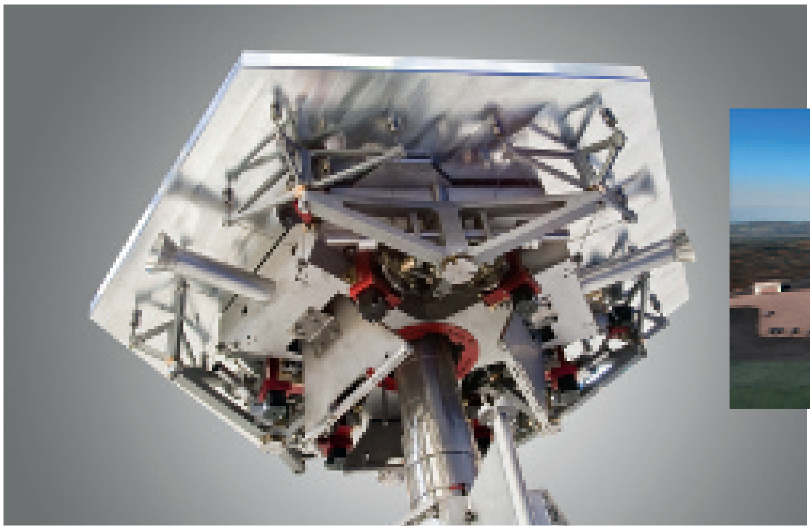
Course providers

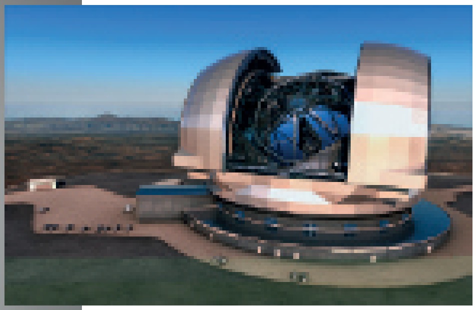
- Engenia (ENG)
  WWW.ENGENIA.NL
- The High Tech Institute (HTI)
  WWW.HIGHTECHINSTITUTE.NL
- Mikrocentrum (MC)
  WWW.MIKROCENTRUM.NL
- LiS Academy (LiS)
  WWW.LISACADEMY.NL

Content Partners

- Dutch Society for Precision Engineering (DSPE)
  WWW.DSPE.NL
- Mechatronics Academy (MA)
  WWW.MECHATRONICS-ACADEMY.NL
- Settels Savenije van Amelsvoort (SSvA)
  WWW.STTLS.NL
- Sioux
  WWW.SIOUX.EU
- Technical Training for Professionals (T2Prof)
  WWW.T2PROF.NL

Dutch consortium helps construct the world's largest telescope





A Dutch consortium will develop the mirror support frame for the E-ELT (inset).

A Dutch consortium, consisting of VDL ETG Projects in Eindhoven, TNO in Delft and NOVA in Leiden, has been awarded a contract to develop the support structure for the main mirror of the European Extremely Large Telescope (E-ELT) in Northern Chile. The order encompasses the design of the final prototypes for the support structure and the construction of a small number of frames. The E-ELT will enable scientific discoveries concerning planets, near galaxies and deep space.

The Dutch support structure will keep the main E-ELT mirror in the desired shape. This mirror will have a diameter of 39 m and will be assembled from 798 hexagonal mirror segments. Every segment has a support of its own, with which the mirror will be positioned with very high accuracy (within 5 nm) in sync with the other 797 segments. Continuous control is achieved by twelve motors and three actuators on each frame, which consists of a static and a moving part.

Early December 2014, ESO gave the green-light for the construction of the E-ELT in two phases. Approximately one billion euros has been commissioned for the first phase.

WWW.VDLETG.COM WWW.ESO.ORG

KMWE premiers on Brainport Industries Campus

Brainport Industries Campus (BIC), the campus for the high-tech manufacturing industry located in North-western Eindhoven, the Netherlands, is becoming reality. Early this month, officials from Eindhoven municipality, the province of Noord-Brabant, the Brainport Industries cooperation and the Brabant Development Agency BOM gave the starting signal for the development. BIC will be part of Brainport Park, which will comprise a high-quality green framework in which a campus with clusters of high-tech mechatronics companies will be established.

BIC is designed to strengthen the competitive position of the Brainport Eindhoven region by creating a unique high-tech ecosystem that facilitates cross-pollination, facility and service sharing and open innovation. The campus will include training, development, prototyping and 'smart industry' (IT) facilities.

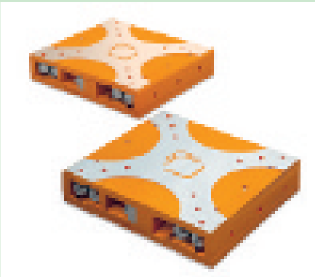
The first company to move to BIC, in 2016, will be KMWE. This supplier for the high-tech equipment industry and aerospace specialises in the high-mix, low-volume, and high-complexity machining of functional critical components and the assembly and engineering of fully-tested mechatronic systems. KMWE (600 employees) is headquartered in Eindhoven and has production facilities in the Netherlands, Malaysia, Turkey and India. KMWE CEO Edward Voncken comments: "We are talking about realising not only a campus, but also the factories of the future. Here we have a unique opportunity to combine all innovative production processes and logistics knowhow with a flexible and 'green' building concept."

WWW.KMWE.COM WWW.BRAINPORTINDUSTRIES.COM

Ultrasonic nano drives

Attocube has introduced the ICS drive technology, thereby pushing piezoelectric nanopositioning one step further adding ultrasonic nano stages to its diverse piezo positioning portfolio. The advanced technology enables inaudible motion combined with high velocity and nanometric accuracy. These features make attocube's ultrasonic nano drives particularly suitable for industrial applications in biotech and life sciences as well as precision machining and optics. Travel range is from 25 mm to 200 mm, typical minimum step size is 50 nm in a fine positioning range of 1 µm.

WWW.ATTOCUBE.COM



High-dynamics hexapod using magnetic direct drives

At the SPS IPC Drives 2014 trade show in Nuremberg, Germany, PI unveiled its newly developed parallel kinematic hexapod systems with magnetic direct drives. They offer extremely high dynamics and are intended for motion simulations and test equipment in industry and research.

The new high-dynamics H-860KMAG Hexapod is based on the PIMag® Voice Coil magnetic drives also developed by PI. The special design with flexure joints and contact-free magnetic drive principle has neither frictional nor rolling parts for guides and joints. It allows for zero-play positioning without mechanical noise in the drivetrain.

An integrated linear encoder ensures reliable position control and repeatable accuracy. Also, due to the device's lightweight design, which consists of extremely stiff carbon fiber parts with low moving masses, fast and precise movements and high accelerations can be realized. This means operating frequencies of > 100 Hz for small strokes. Hexapods with magnetic PIMag® direct drives achieve velocities of several hundred mm/s and accelerations of up to 4 g. The reference-class 6-axis system has a parallel kinematic structure for six degrees of freedom and offers precise tracking of pre-defined trajectories, sinusoidal curves and freely definable paths with high trajectory accuracy.

WWW.PHYSIKINSTRUMENTE.COM

Product info: MATLAB & Simulink update

The latest release, 2014b, of MATLAB®, the high-level language and interactive environment for numerical computation, visualisation and programming, includes a new graphics system, increased support for big data, features for packaging and sharing code, and source control integration. The 2014b release of Simulink®, the block diagram environment for multi-domain simulation and model-based design, has significant updates with new features for accelerating model building and running consecutive simulations. With these new capabilities, engineers and scientists in all major industries can more easily analyse and visualise their data.

MATLAB

The updated default colours, fonts, and styles in the new graphics system make it easier to interpret and gain insight from the data. New syntax for changing properties of graphics objects makes it simpler to customise visualisations. Additional new features include rotatable tick labels, support for multilingual text and symbols, and automatic updating of date and time tick labels.
Additional big data capabilities provide more efficient ways to process data sets that don't fit into memory. These include simplified ways to access and analyse big data text files and databases, and support for the MapReduce programming technique directly within MATLAB. These capabilities also scale for use on the big data platform, Hadoop.
MATLAB 2014b now offers Git and Subversion source control system integration through the Current Folder Browser, including the ability to sync from web-hosted repositories such as those on GitHub. Custom toolboxes can be packaged as single, installable files. This makes it easier to distribute, as well as install and manage the shared code.

Simulink

- Smart editing cues for accelerated model building, and editor views for annotations and interfaces.
- Fast simulation restart for running consecutive simulations quickly.
- Simulink Functions for creating and calling reusable functions from anywhere in Simulink and Stateflow.
- Live streaming and data cursors in Simulation Data Inspector.

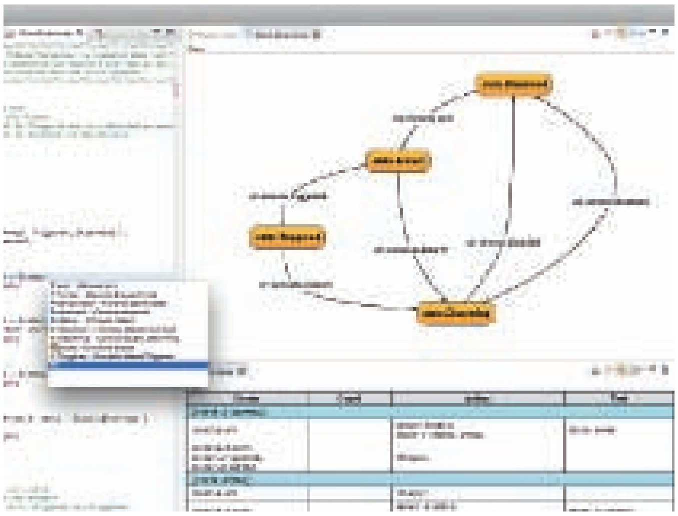
MathWorks will be exhibiting at High-Tech Systems 2015 on 25-26 March in 's-Hertogenbosch, the Netherlands.

WWW.MATHWORKS.COM

New model-driven software engineering tool

December 2014, Verum Software Tools launched an evaluation version of Dezyne. This new generation of model-driven software engineering tools, according to a press release, enables software engineers to create, explore and verify designs for software-controlled systems, leading to generated code that is robust, reliable and trustworthy.

Based on a powerful, open modelling language, Dezyne gives software engineers the ability to fully explore their designs using advanced simulation techniques. Automated formal verification discovers hidden defects that are otherwise practically impossible to find. Efficient code generation instantly turns verified models into executable results.



Screenshot of the Dezyne software engineering tool.

Dezyne is integrated into the Eclipse and Microsoft Visual Studio IDEs (Integrated Development Environments) and linked to powerful cloud-based simulation, verification and code generation engines. Within the IDE, Dezyne provides engineers with an unparalleled, interactive view of the structure and behaviour of their designs. Freed from the constraints of conventional development methods, software engineers are able to focus on rapidly creating innovative software-controlled systems.

WWW.VERUM.COM

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The LiS is founded in 1901 by the famous scientist prof. Kamerlingh Onnes. Nowadays the LiS is a modern school for vocational training on level 4 MBO-BOL. The school encourages establishing projects in close cooperation with contractors and scientific institutes, allowing for high level "real life" work.

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Dutch Precision Technology (DPT) is the principal association for precision cutting in the Netherlands. The companies affiliated with DPT guarantee expertise, quality, flexibility and effective cooperation. DPT has top specialists for all kinds of precision processes, combined with options for assembling parts into composites and/or complete systems or products.

Ultra-Precision Metrology & Engineering

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