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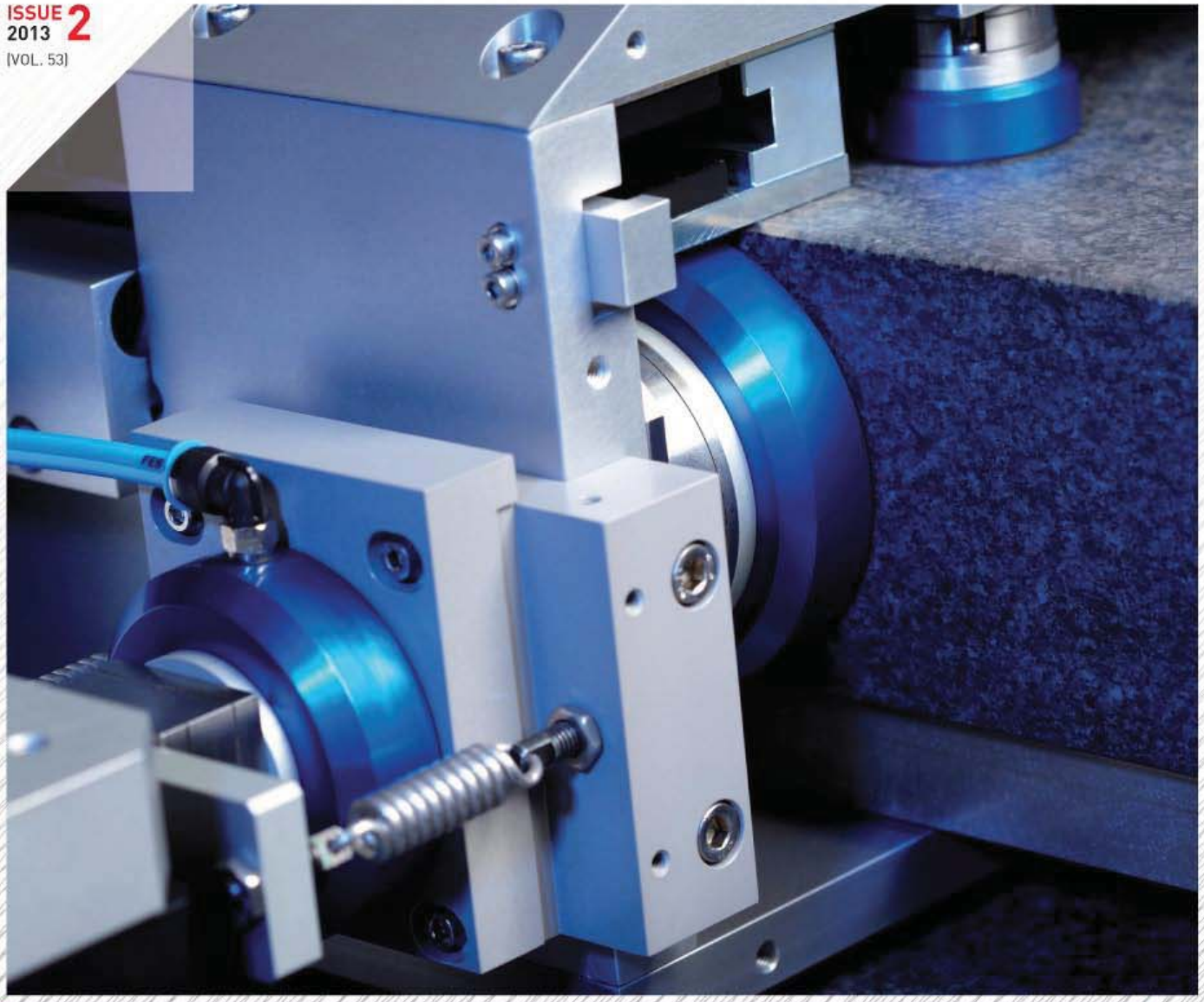
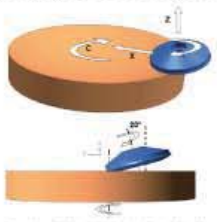


- ASTRONOMICAL MECHATRONICS: **STARBUGS**
- **DAMPING** IN P(I)D SYSTEMS
- THE BOX: **GRINDING FREE-FORMS**
- 1 μN **CONTACT FORCE MEASURING**

OFFICIAL CATALOGUE
HIGH-TECH SYSTEMS 2013
24-25 APRIL, EINDHOVEN



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Professional journal on precision engineering and the official organ of DSPE, the Dutch Society for Precision Engineering. Mikroniek provides current information about scientific, technical and business developments in the fields of precision engineering, mechatronics and optics.
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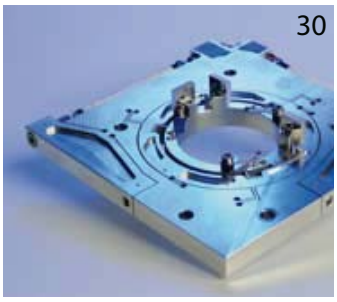

FEATURES

DUTCH-GERMAN COOPERATION

It is a great pleasure for me to introduce the German activities on precision engineering. The VDE (Association for Electrical, Electronic & Information Technologies), having 35,000 members, and VDI (Association of German Engineers), having 150,000 members, are dedicated supporters of the German high-tech industry. As part of this big engineering community, the GMM (VDE/VDI Society for Microelectronics, Microsystems and Precision Engineering) counts about 10,000 members. GMM provides a platform for the exchange of know-how in about 50 committees and by offering about 10 workshops and conferences per year – most of the work is done by volunteers.

As many of the companies of our members operate internationally, GMM is no longer focused solely on Germany. For example, cooperation has been established with CEA-Leti in Grenoble at several levels and the VDE office in Brussels has been supporting the approach to European policies. GMM has been in contact with the DSPE (Dutch Society for Precision Engineering) for several months to establish common activities. As both societies cover similar technologies, we are optimistic that this contact will be very fruitful, providing significant benefits for the members of both societies.

As a first step, GMM is going to support High-Tech Systems in Eindhoven, as this is a good approach for both our industries to operate successfully and present the relevance of our actions to politics. Further steps towards cooperation between GMM and DSPE are in preparation. We plan to bring together the experts of both societies for a workshop in June. According to a first, optimistic impression, we assume that the strengths of both societies can be combined in order to increase our profile and reach our individual goals.

As GMM is not limited to German members, it might also be a useful approach to invite Dutch engineers to our GMM activities. In any case, please feel free to contact me for any kind of questions which might arise. I am proud of each step that brings us closer to a Dutch-German cooperation.

Dr. Ronald Schnabel
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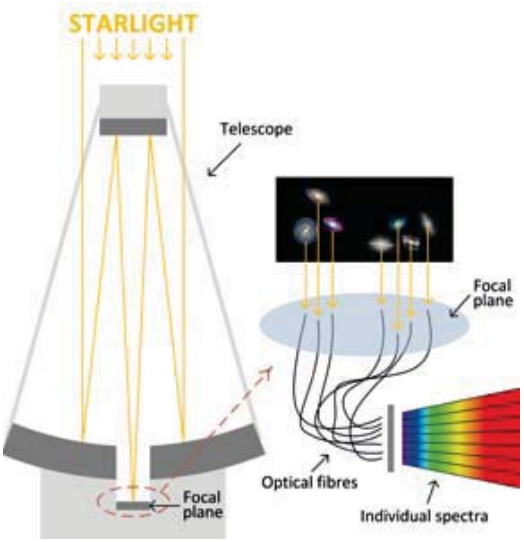
ASTRONOMICAL MECHATRONICS: STARBUGS

For hundreds of years, astronomy has relied on developments at the cutting edge of technology. 'Starbugs' are miniature piezoelectric robots that can actively reposition hundreds of optical fibres at the focus of the world's largest telescopes, allowing astronomers to observe thousands of objects in a single night. This article presents an overview of Starbug technology and its relevance not only as a specialised solution in the world of astronomy, but also as a generic micro-positioning system with possible uses elsewhere.

JAMES GILBERT



1 *Multi-object spectroscopy involves catching starlight with optical fibres, and then guiding the light from many (hundreds or even thousands of) objects to a spectrograph for spectral analysis.*

1

It can be disappointing to learn that modern scientific telescopes don't have an eyepiece that you can look through. In fact, much of the data being gathered from the night sky is not in the form of an image at all. It is not photography, but *spectroscopy* that is the main tool of many of today's astronomers. With spectroscopy – analysing the wavelength content of light from objects in the sky – a wealth of information can be found; from a star's chemical composition to its age, from a galaxy's distance to the velocity of its rotation. Even undiscovered planets can be revealed in spectra as they orbit distant suns.

Fibre optics

Using fibre optics, we can now use a single telescope to record spectra for hundreds or even thousands of objects simultaneously (Figure 1). Where we once placed photographic film, we now place optical fibres on individual targets in the sky. This technique, known as multi-object spectroscopy, presents some unique engineering challenges relating to the efficient positioning of these fibres. Often the tip of every fibre must be within a few microns of its target position in order to catch enough light for analysis by the spectrograph. What's more is that these fibres must be completely reconfigured several times per night.

AUTHOR'S NOTE

James Gilbert is an electronics engineer at the Australian Astronomical Observatory in Sydney, Australia. He has been the lead developer of Starbug technology since 2010.
The results in this article were first presented at the SPIE Astronomical Telescopes + Instrumentation 2012 conference in Amsterdam, the Netherlands, with the following paper:
Gilbert, J., Goodwin, M., Heijmans, J., Muller, R., Miziarski, S., Brzeski, J., Waller, L., Saunders, W., Bennet, A. and Tims, J., "Starbugs: all-singing, all-dancing fibre positioning robots".

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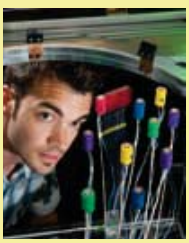
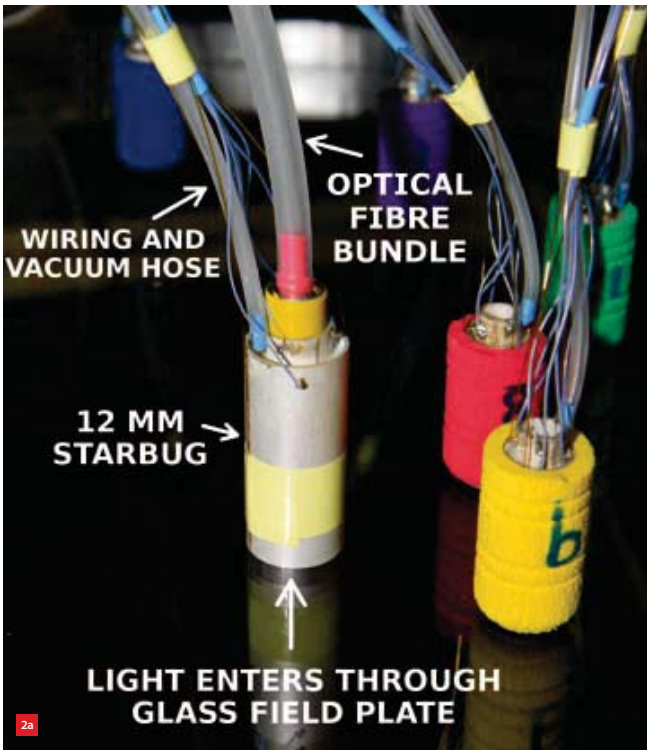
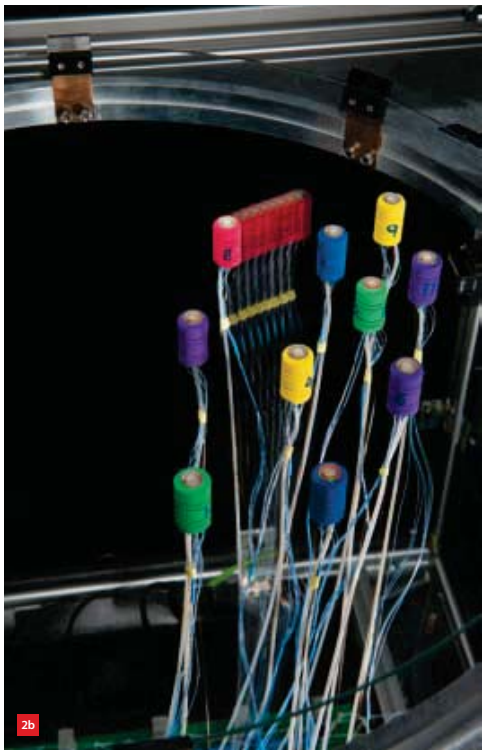






2 *Starbug prototypes.*
(a) Typical diameters of 12 mm (left) and 8 mm (right).
(b) A small-scale system.
3 *Starbugs are planned for use on the 25 m Giant Magellan Telescope, currently under construction in Chile.*

Enter 'the Starbug'

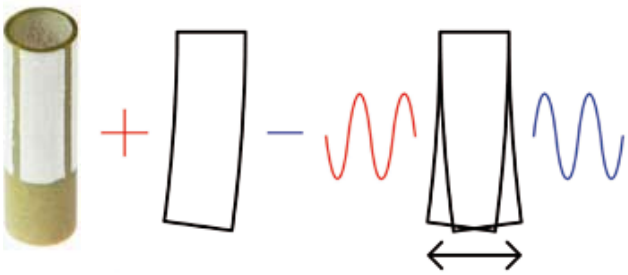
Starbugs (Figure 2) are novel discrete-stepping miniature robots developed by the Australian Astronomical Observatory (AAO) to solve the specific problem of fast, accurate, high-multiplex fibre positioning on a telescope's focal plane. They are remarkably simple devices. With just two monolithic piezo actuators a Starbug can take individual steps of a few microns, yet has the capacity to move a payload several millimeters per second – even on a vertical surface. In large numbers, Starbugs form a flexible micro-positioning system that allows independent closed-loop positional control of many fibres or other optical components in parallel.

The Starbug concept was successfully demonstrated in the lab in 2011 and will be developed into a fully functional telescope instrument by 2015. These early systems are precursors to a large-scale fibre positioner called MANIFEST (Many Instrument Fiber System), which is planned for the next generation Giant Magellan Telescope (GMT). MANIFEST will feature approximately 500 Star--bugs deployed across a ~1.3 m diameter focal surface. The GMT (Figure 3) is due for completion in 2020 and will have a segmented primary mirror with an overall diameter of 25 m.

Principle of operation

Starbugs use a pair of piezoceramic tube actuators to produce a micro-stepping motion. Their simple design has only three major parts: two concentric piezo tubes, held together by a solid ring at one end. The application of an electrical potential to electrodes on the walls of these tubes will cause deformations (Figure 4) that can be exploited to produce a stepping or 'walking' motion (Figure 5).

The absence of any obstruction within a Starbug's central piezo tube means that it has a completely clear aperture for the insertion of optical components. This is not limited to single optical fibres; large fibre bundles, miniature lens assemblies, and small mirrors can also be carried. Indeed, a Starbug's payload needn't be an optical component at all.



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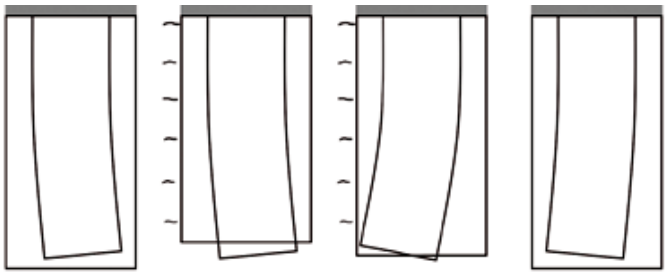

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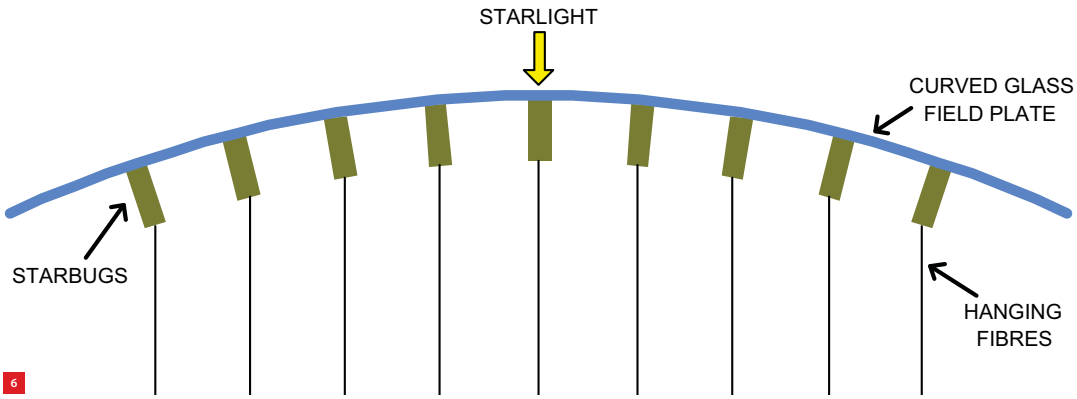

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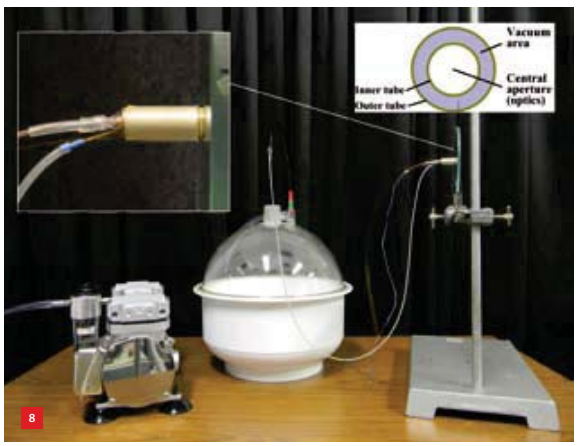
Four electrical signals (waveforms) with amplitudes of ~200 V are required to produce a Starbug's stepping motion. But these displacements are small (of order 10 µm), and therefore a smooth surface such as glass or polished metal is necessary in order to permit free movement. For astronomy, the Starbug's ability to walk on a glass surface also presents an optical advantage, and hence an 'inverted hanging' format is used so that electrical wiring and other fibres do not obstruct the incoming starlight (Figure 6). Starbugs can also be made to move on curved surfaces, which is necessary when a telescope does not have a perfectly flat focal surface.

7

Starbugs require an attractive force to hold them to the surface on which they move. For applications where the surface is magnetic, this can be achieved by placing a magnet within or around the Starbug (Figure 7). If the surface is non-magnetic, such as glass in the case of a telescope, then a vacuum is used to provide the necessary attractive force. The vacuum is created in between the Starbug's two piezo tubes, fed via a thin hose that is connected to an evacuated chamber (Figure 8). While this method may not seem robust on first thought, the leakage of air as the Starbug moves is actually very slight due to its actuator displacements being so small. The actuator ends are also optically polished, which ensures minimal airflow when the Starbug is static.



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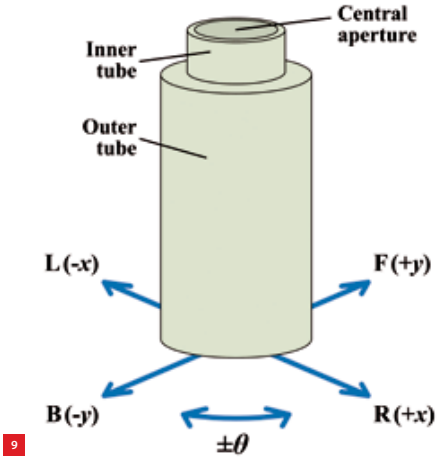
4 *A piezoceramic tube actuator (left) exhibits a change in length with an applied voltage. Applying bi-polar voltages to electrodes on opposite sides of the actuator results in a bending motion (middle); dynamic motion can be achieved using periodic voltage waveforms (right).*

5 *Time-varying electrical signals produce a Starbug's walking motion: first its outer piezo tube extends and its inner piezo tube bends; next the outer tube contracts and the inner tube bends in the opposite direction, resulting in a microscopic 'step'; this cycle repeats hundreds of times per second in order to produce a fast forward motion.*

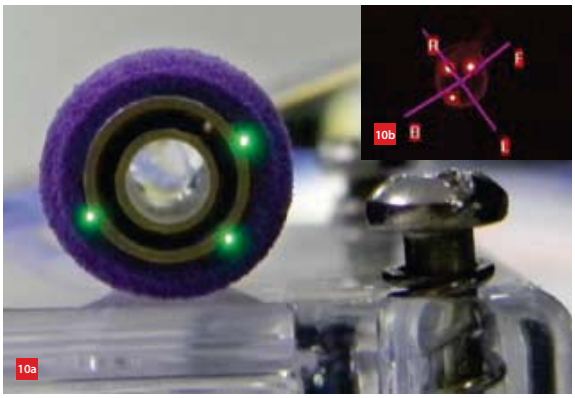
6 *Starbugs are designed to move across the underside of a curved glass 'field plate', with light from the telescope passing through the plate and into the Starbugs' optical fibres (drawing not to scale).*

7 *A magnet can be placed within or (shown) around a Starbug for positioning on magnetic surfaces. This conceptual image shows a mounted prism mirror for redirecting or 'picking-off' incoming light beams.*

8 *Starbugs can be attached to smooth surfaces such as glass by creating an internal vacuum between their piezo actuators.*



9 *A Starbug provides fast and accurate movement along orthogonal (x, y) axes, as well as rotation (θ) about its centre.*



10 *Starbugs carry three back-illuminated fibres as metrology markers. (a) The markers are arranged in an asymmetric pattern to provide angular as well as positional information. (b) Calibrated movement vectors are recorded relative to the three markers.*

The direction in which a Starbug moves is controlled by applying waveforms to different parts of its inner piezo actuator. This piezo tube has four equally spaced electrodes around its outer wall, which means that steps can be made in four orthogonal directions (±x and ±y). Furthermore, dividing the electrodes on the outer piezo tube has provided a simple method of rotating a Starbug about its centre. The rotating motion is created by bending the outer tube in a side-to-side cycle that is out of phase with that of the inner tube. This extra degree of freedom makes each Starbug extremely flexible in its capabilities: fast and accurate micro-stepping in x, y and theta (Figure 9).

Control system

Precise positioning of Starbugs is achieved with a closed-loop control system. Control software tracks Starbugs in real-time via a high-resolution metrology camera which images the entire positioning area or 'field'. A simple calibration routine determines the expected step size of every Starbug in each movement direction and accounts for any performance variations between devices. The Starbugs have three illuminated markers on their body that are arranged in an asymmetric pattern to provide angular information as well as the Starbug's location (Figure 10). The software uses centroid algorithms to obtain sub-pixel coordinates of every Starbug in the field relative to fixed reference points on the positioning surface. On a telescope these coordinates would then be mapped to the night sky.

The electronics system (Figure 11) is responsible for providing Starbugs with the electrical signals necessary to drive them in a given direction for a given number of steps as dictated by the control software. Movement instructions for each Starbug are received and interpreted by a microcontroller, which manages the waveform generation and signal routing for all Starbugs under its control. The waveforms are sent to high-voltage power amplifiers in order to produce the amplitudes necessary (up to 200 V). These high-voltage signals are then connected to the relevant Starbug electrodes using an array of solid-state relays. A crucial point is that this architecture allows many Starbugs to share one set of drive waveforms, with their movement controlled by re-routing the signal paths rather than changing the signals themselves.

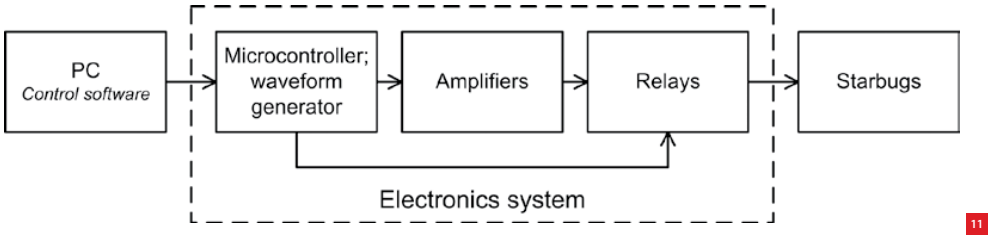
Modularity and scalability

The modular nature of the Starbugs control hardware means that it is easily scalable. A single control electronics 'module' described above can control approximately 100 Starbugs and is about the size of an industrial rack-mount computer. These modules can be replicated to build up a system of many hundreds or even thousands of Starbugs (Figure 12).

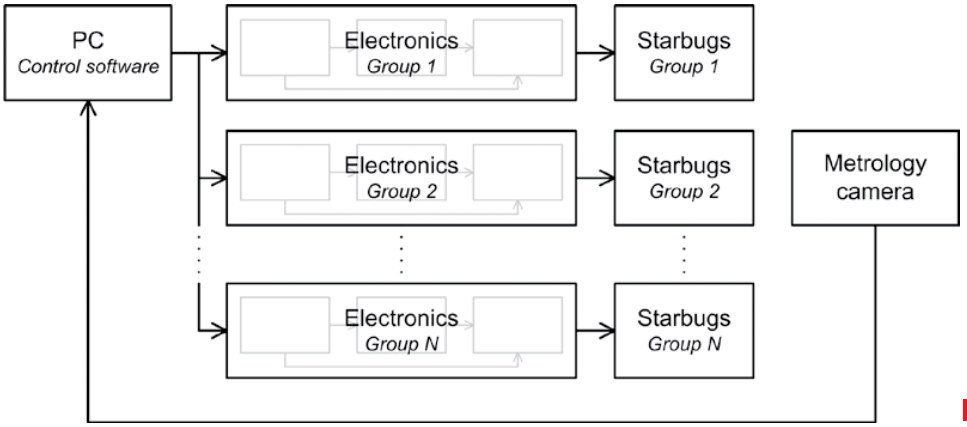
Apart from the physical space available for control hardware, the maximum possible number of Starbugs may be limited by software. As the multiplex increases, the software system must maintain centroid coordinates for all Starbugs in addition to managing collision avoidance and fibre/wiring entanglement. Performing this in real-time (or with minimal overheads) could necessitate more than a single computer. The solution here is to divide the metrology system into subgroups, each managing different areas of the field. Indeed, multiple cameras may be needed when imaging large fields in order to provide a sufficient feedback resolution and frame rate.

Performance

Starbugs can be made in various sizes to suit various applications. Their design involves a trade-off between three main parameters: i) maximum speed; ii) maximum load; and iii) minimum payload spacing (pitch). Three Starbug designs have been prototyped (Figure 13), which will be referred to as 'type-0', 'type-1' and 'type-2' Starbugs for the purpose of this article. Table 1 shows their specifications.



11 *The electronics system provides multiple Starbugs with the necessary high-voltage signals.*



12 *The modular nature of the Starbugs control architecture allows for easy scaling of the system from tens of Starbugs to thousands, with minimal data transfer requirements.*

Table 1 *Characteristics of the three Starbug types shown in Figure 13.*

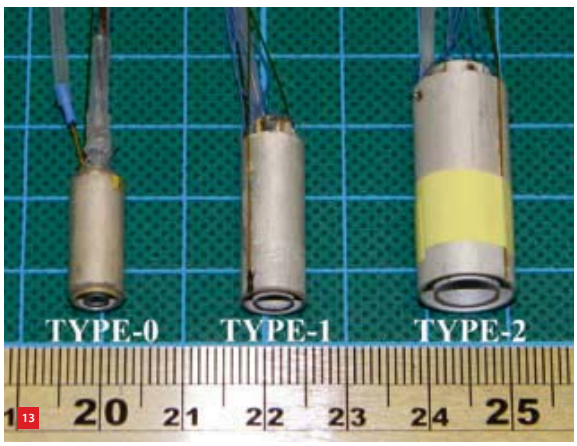
	Type-0	Type-1	Type-2
Outside diameter	6.4 mm	8.0 mm	12 mm
Central aperture diameter	2.2 mm	4.0 mm	7.0 mm
Height	20 mm	25 mm	30 mm

The discrete step size of a Starbug is proportional to the amplitude of the waveform applied to its inner piezo tube (Figure 14). A Starbug's minimum achievable step size defines its positioning resolution. Step sizes of < 4 µm are readily achievable with all Starbug prototypes. Repeatable sub-micron positioning has also been demonstrated, but was found to be dependent on the quality of assembly. When rotating, type-1 Starbugs have a minimum angular step size of ~3 arcmins (Figure 15).

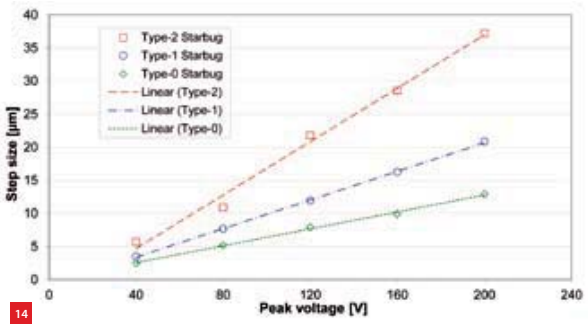
How fast a Starbug moves for a given step size is set by the rate at which it steps, i.e. the frequency of the drive waveforms. For example, Figure 14 shows a maximum x-y step size of ~21 µm for a type-1 Starbug and so for a nominal waveform frequency of 100 Hz the speed would be 2.1 mm/s (theoretical). Testing has shown that the actual relationship between drive frequency and Starbug speed is somewhat dependent on the Starbug design (Figure 16). For most frequencies we see a linear relationship, but in certain cases some slippage is apparent. This may be the result of resonant modes within the Starbug itself. For example, the unpredictable nature of high-speed operation for type-1 Starbugs is apparent at 300 Hz. What we see is a maximum stable speed of ~3.7 mm/s for type-1 Starbugs at 200 Hz and ~7.5 mm/s for type-2 Starbugs at 300 Hz. With angular speed we also see a linear increase with frequency (Figure 17) and a maximum speed of 56 deg/s for type-1 Starbugs.

The type-1 Starbug presents an optimal trade-off of performance with footprint for most fibre positioning tasks and therefore is the current baseline Starbug design. A complete set of key performance figures for the type-1 Starbug is shown in Table 2.

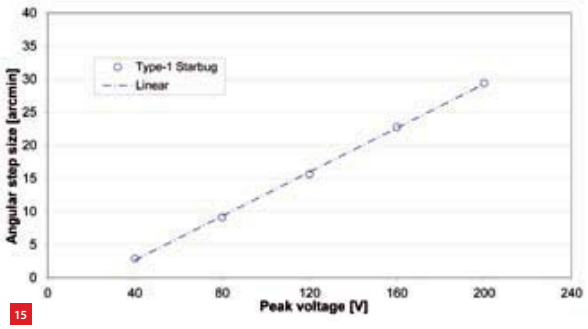
High-speed x-y movement is particularly desirable when a Starbug must position over long distances, and can be effectively implemented as part of an initial 'coarse'



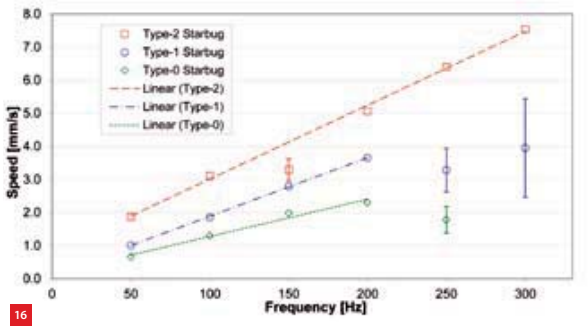
13 *Three Starbug prototypes of different sizes; scale is in millimeters.*



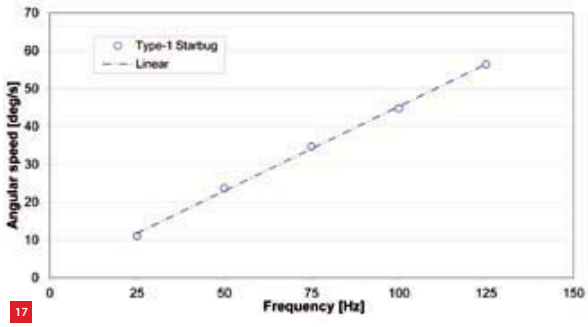
14 *There is a linear relationship between a Starbug's x-y step size and waveform voltage; step sizes of a few microns can be achieved for use in fine positioning; results are for a nominal drive frequency of 100 Hz.*



15 *There is a linear relationship between a Starbug's angular step size and waveform voltage; step sizes of a few arcmins can be achieved for use in fine positioning; results are for a nominal drive frequency of 75 Hz.*



16 *There is a linear relationship between Starbug speed and (lower) waveform frequencies; all values were repeatable to < 2% except where error bars are shown; results are for a drive voltage of 200 V.*



17 *There is a linear relationship between Starbug angular speed and waveform frequency; behaviour at frequencies higher than 125 Hz was erratic and is not included; results are for a drive voltage of 200 V.*

positioning stage. Fast stepping is less suitable for fine positioning though, due to reduced repeatability. This has led naturally to a two-stage approach for field reconfigurations with Starbugs. The first stage uses a higher frequency and the maximum step size to position a Starbug near its target in the shortest practical time. The second stage then uses a lower frequency and a reduced step size to position the Starbug precisely on its target.

Table 2 *Key performance figures for type-1 Starbugs.*

Degrees of freedom	x, y, θ
Minimum x-y step size	< 4 µm
Minimum angular step size	3 arcmin
Maximum angular speed	> 55 deg/s
Maximum speed on horizontal surface	> 3.7 mm/s
Maximum speed on vertical surface	> 3.0 mm/s
Nominal speed on horizontal surface	1.9 mm/s
Nominal speed on vertical surface	1.6 mm/s

A demonstration video of a small-scale Starbug system under full parallel closed-loop control can be viewed at www.dspe.nl/files/mikroniek/additional/3_parallel_demonstration.mov

Fibre reconfiguration on telescopes with current technology has limitations. One example of an existing technique is the sequential 'pick and place' robotic arm, which positions fibres one-by-one. This process can take almost an hour for present-day instruments with around 400 fibres, but using a Starbugs system would likely be completed in less than three minutes. For the next generation of extremely large optical telescopes, the increasing size of the accessible focal plane means that a truly parallelised system is essential so as to not waste the valuable hours of darkness. Starbugs, with their ability to be independently yet simultaneously controlled in large numbers, present an attractive solution to this very problem.

The future of Starbugs

Starbugs are set to make a substantial impact in the astronomical community during the coming years. This simple, low-cost technology offers a level of flexibility never before seen in multi-object astronomy, enabling faster data collection and ultimately increasing the rate at which we can learn about the Universe.

Starbugs, however, are not limited to use in the rather specialised world of astronomical research. As a complete system Starbug positioners are readily adaptable to any situation where one wishes to quickly and accurately position many payloads across a surface. Moreover, as a single device the Starbug is an efficient discrete-stepping motor capable of translating and rotating relative to any smooth face. The nature of its stepping mechanism gives the Starbug excellent performance in terms of repeatability – far better than that of most 'stick-slip' mechanisms. But despite these merits it remains to be seen whether an industrial application, or even another scientific application, exists for Starbug technology. In the meantime, work continues on what we at the AAO firmly believe is the next big thing in astronomical mechatronics. ■

HEMBRUG LAUNCHES THE BOX

Cranfield University and Hembrug together took up the challenge to precision-grind free-formed mirrors as large as 1.46 m. Early in the next decade, nearly 800 of these mirrors will make up the European Extra Large Telescope. The E-ELT will probably be able to track down earth-like habitable planets around other stars and solve many other problems of modern observational astronomy. Recently, the fully hydrostatic bearing grinding machine The BoX proved that it can meet the stringent demands imposed by ESO scientists.

FRANS ZUURVEEN

AUTHOR'S NOTE

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

Paul Shore is head of the Cranfield University Precision Engineering Institute in the UK. When he was approached by the European Southern Observatory (ESO) about the precision-technological problems of the E-ELT, he already was aware of the hydrostatic bearing technological expertise of Hembrug Machine Tools in Haarlem, the Netherlands. He realised that this expertise would fit very well with the demands associated with the precision-grinding machine to be developed in his institute. This machine was dubbed 'The BoX' (Big optiX).

During the development of The BoX, Loxham Precision Ltd was formed as a spin-out of Cranfield University. One of Loxham's activities was the design of the software necessary to control the path of the grinding wheel when making complicated free-form surfaces. The company licensed its programmes, intellectual property and associated know-how to Hembrug. The result of these collaborations is that the fully hydrostatic bearing grinding machine The BoX is being manufactured, marketed and branded by Hembrug.

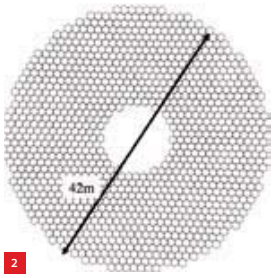
1 *Computer-drawn impression of the European Extra Large Telescope to be installed in Chile.*

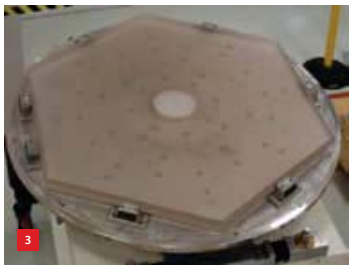
The Extra Large Telescope

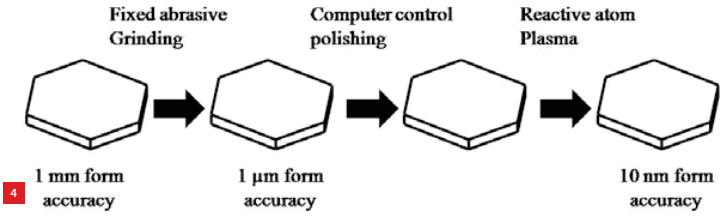
ESO plans to install the E-ELT at its final position on the 3,060 m high mountain Cerro Armazones, near Paranal in Chile, in the early 2020s, see Figure 1. The complete European project will cost nearly $1.1 \cdot 10^9$ euros (base 2012). The primary mirror will have a diameter of 39 m and a secondary monolithic deformable mirror takes care of compensating errors due to atmospheric conditions (adaptive optics).

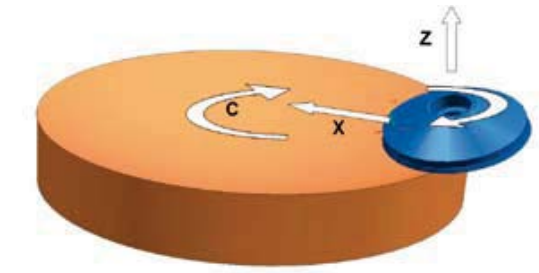
The E-ELT is designed as a Keck-telescope: a large mirror consisting of lots of single, contiguous mirrors. The design is named after Howard B. Keck, who financed the design and construction of such a telescope, which was set up in 1985 near the summit of Mauna Kea in Hawaii at 4,145 m altitude. Later, a second Keck telescope was positioned at a distance of 85 m next to the first one. The Keck I and Keck II telescopes can work together as the Keck Interferometer, giving them an effective angular resolution in one direction equal to that of one 85 m mirror.

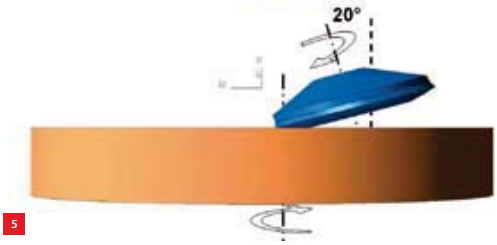
The E-ELT primary mirror consists of 798 hexagonal elements with an external dimension across corners of 1.46 m and a thickness of about 50 mm, see Figure 2. They are individually specified as non-spherical and non-rotationally symmetric free-forms with a form accuracy of 20 nm rms and a roughness better than 1 nm rms. Their average radius

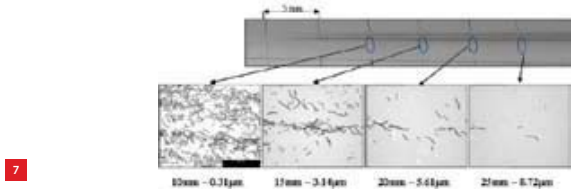












2 *The E-ELT primary mirror with a diameter of 39 m consists of 798 hexagonal elements with an external dimension across corners of 1.46 m.*
3 *A prototype hexagonal mirror from glass-ceramic ULE (Ultra Low Expansion) from Corning, manufactured by Cranfield University using The BoX, the prototype grinding machine.*
4 *The machining sequence for one mirror: from a rough glass-ceramic blank to a final mirror with submicron accuracy.*
5 *The three-axis R-theta grinding mode.*
6 *The inclined spindle with toroidal grinding wheel.*
7 *Sub-surface damage made visible at different distances from the mirror centre.*

of curvature amounts to about 69 m, with a typical departure from nominal sphere of about 150 µm. Each mirror segment is actively mounted, so its tip, tilt and piston orientation (TTP) can be adjusted. (TTP means two angular degrees of freedom plus one translation orthogonal to the mirror surface.)

Cranfield University has been engaged in a UK consortium contracted by ESO to manufacture seven prototype mirrors made from various glass-ceramic materials with very low thermal expansion, see Figure 3. Schott's well-known Zerodur is one of the candidate materials.

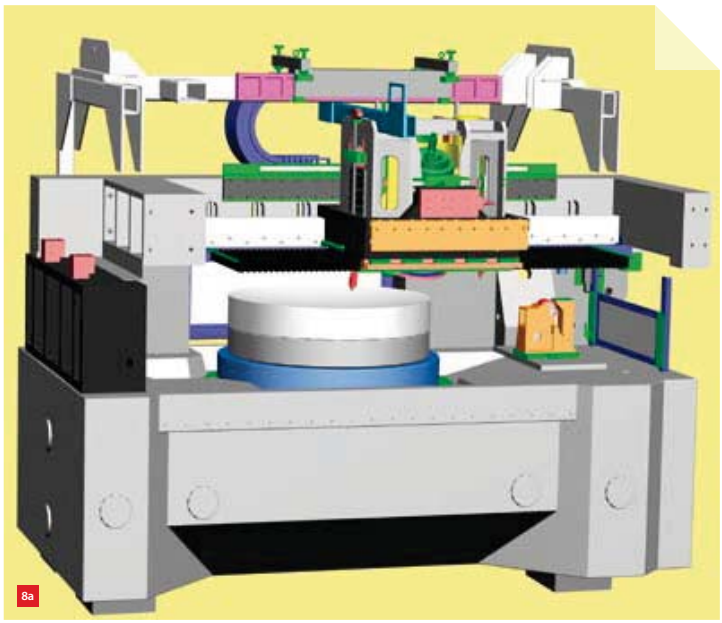
Precision-grinding a mirror

Figure 4 illustrates the machining sequence from a relatively rough glass-ceramic blank to a final mirror with submicron accuracy and nanometer smoothness. After a rather straightforward machining grinding operation on a conventional grinding machine, The BoX continues to grind the mirror in three processing steps with successive depths of cut reducing from 500 down to 50 µm.

In addition to the problem of realising the required free-form with high accuracy, Cranfield University was faced with two other challenges: limiting the machining time for such a large workpiece and reducing sub-surface damage. Normally, grinding such a large object in three cycles would take up about 100 hours, causing significant tool wear and making the manufacture of nearly 800 mirrors very expensive. And a high degree of sub-surface damage would need a lot of painstakingly slow and expensive polishing.

A relatively large material removal rate of 200 mm^3/sec could be reached by adopting a three-axis configuration in an R-theta grinding mode, see Figure 5, with a toroid-shaped, composite-bonded diamond grinding wheel, see Figure 6. The consequence of this sophisticated configuration was the need of highly advanced tool-path software, a problem that Loxham Precision solved satisfactorily.

Despite the increased material removal rates, the sub-surface damage could be reduced thanks to the machine characteristics: high stiffness, low moving masses by direct-drive linear and torque motors, and virtual absence of vibrations damped through fluid-film bearings. Sub-surface damage analysis techniques developed at Lawrence Livermore National Labs in the US were used to investigate the depth of induced sub-surface damage. By polishing surfaces in tapered grooves parallel to the grinding direction, the fracture depths appeared to be as small as 4 µm. Figure 7 shows some pictures of the – relatively low degree of – sub-surface damage.



8 *The BoX grinding machine.*
(a) Design.
(b) Realisation.

9 *A mirror blank ready to be transported into The BoX.*

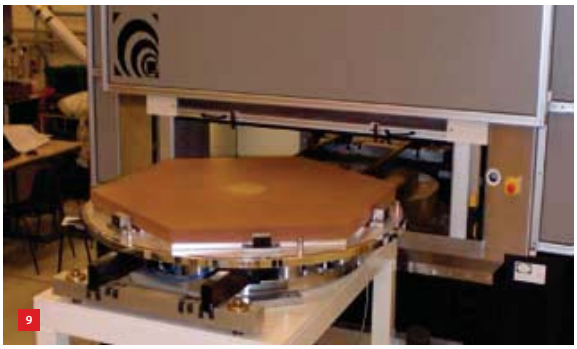
10 *The toroidal grinding wheel starts a grinding cycle.*

Getting the shape of the toroidal wheel correct demands a wheel-truing process. This is performed against a metal-bonded diamond wheel based on techniques borrowed from the bearing industry. Dressing against an aluminium-oxide stick is necessary to expose fresh diamond abrasives from the bond. This is done in between finishing cutting cycles. Truing is also performed between roughing and finishing cuts. Wheel shape and wear can be measured in situ by imprinting the circumference profile onto a soft dressing stick, thanks to the additive function of the grinding machine as a measuring instrument (to be explained later).

The grinding machine

As known from the Hembrug Mikroturn machines, The BoX is a fully hydrostatically hydraulic precision tool, up to now marked with the Cranfield name, see Figure 8. In the near future, successive machines will be branded as a Hembrug Machine Tools product. The machine will be an answer to the growing demand for large free-form optical surfaces.
Specifications for The BoX include a maximum grinding diameter of 1,500 mm (on request 2,000 mm), with a maximum part weight of 1,500 kg. The rotary table run-out is less than 200 nm. The CNC resolution amounts to 1 nm and the positioning accuracy of the X-axis is 1 µm at a position repeatability of 100 nm.

Figure 9 shows a mirror blank ready to be transported into the grinding machine. Figure 10 shows a toroidal grinding wheel starting a grinding cycle. The wheel has an outside diameter of 325 mm, the diamond grit sizes range from



76 down to 25 µm with varying levels of particle concentration.

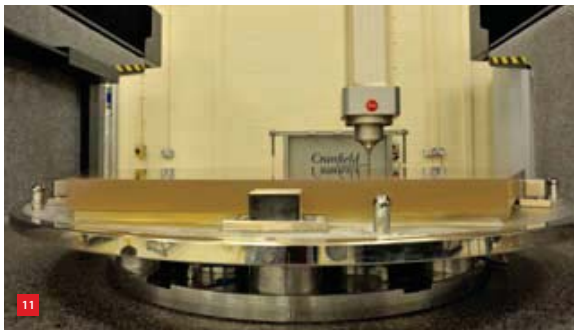
The BoX as a measuring instrument

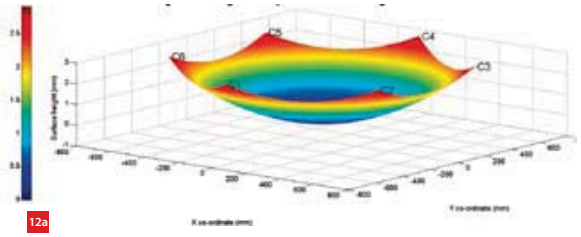
Not only is The BoX a highly accurate free-form grinding machine, it also has coordinate measuring machine (CMM) capability, thanks to the hydrostatic precision slides and the

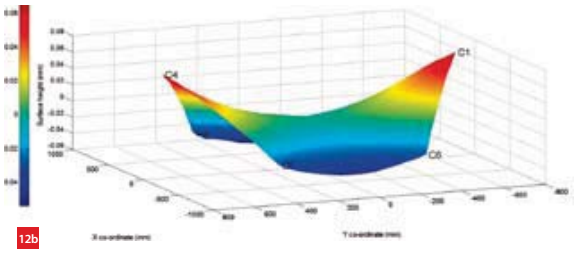
3D position measurement system. This is based on optical scales with 1 nm measurement resolution and an accuracy better than 0.5 µm.

To make The BoX function as a real CMM, a hybrid interferometric contacting probe system has been integrated. It works with a small interferometer mounted onto an air-bearing supported slide, referenced to a calibrated precision-optical straightedge. The probe is brought into contact with the workpiece surface and 'nulled', at which time measurements are taken by the interferometer. Also an automatic workpiece location system has been added. The system software includes a comprehensive surface form mapping data collection and systematic-error compensation.

Cranfield University has mainly used The BoX measurement data for error compensation and for correlating those data to external measurement data from a Leitz PMM-F 30.20.10 universal measuring instrument and gear inspection system, see Figure 11. Figure 12a shows the deviation from the desired form of one of the prototype mirrors made from Zerodur, measured with the Leitz PMM-F in segment telescope co-ordinates. Figure 12b shows the deviation from an ideal spherical form. When measuring the deviation from the non-spherical free-form, the rms deviation shows to be significantly lower than 1 µm and there are no visible edge chippings. The measurement data are to be used for final corrective polishing at the Opto-electronics Technology and Incubation Centre in North Wales, which utilises laser interferometry techniques for the determination of polishing tool paths.







11 *Measuring a ground mirror on a CMM Leitz PMM-F.*
12 *Measurement results for a prototype mirror with 580,000 probing points.*
(a) Deviation from desired form.
(b) Deviation from ideal spherical form.

To conclude

Who invented the telescope, Galileo Galilei, Sacharias Jansen or Hans Lipperhey? Was it one of the last two, who both lived in the Dutch city of Middelburg, not far from the author's home town? Be that as it may, Jansen and Lipperhey were both scientists and craftsmen. They produced the lenses for their sensational invention completely on their own in their glass workshop. Lipperhey presented his homemade telescope to the Dutch government in 1608. Galilei is said to have presented his telescope one year later and succeeded in observing the moons of Jupiter.

In the early 21st century, the E-ELT – quite different from the research goals in the 17th century – probably will discover planets many light years away that may be suited for producing life. Another important difference is that this modern optical achievement will be the fruit of European-wide or even world-wide co-operation. And even more specifically, the high-tech mirrors will be the result of cross-Channel co-operation. Thanks to this example of fruitful partnership, Hembrug Machine Tools has been able to significantly enlarge its product portfolio. ■

INFORMATION

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THE ROLE OF DAMPING IN P(I)D SYSTEMS

For motion controller design, the reduced plant model is used in which high-frequency dynamics are disregarded. However, the maximum achievable closed-loop bandwidth is limited by the very same dynamics. The extent of their influence depends on the character of the high-frequency modes. Another aspect that impacts the stability of the closed-loop system, is the damping present in the plant. These issues are addressed in this paper. The results provide design rules of thumb concerning the maximum achievable value of the crossover frequency, a key tuning parameter.

BAYAN BABAKHANI, THEO DE VRIES AND JOB VAN AMERONGEN

Introduction

Model-based motion controllers are designed using a model of the actual plant, based on the knowledge of the system. Some effects within the system, such as static friction and damping, are difficult to model. In addition, a high-accuracy model is time-consuming in simulations. Therefore, a reduced model of the actual plant is often used for simulation and control-design purposes. The rules of thumb for tuning motion controllers are similarly based on the reduced models. These low-order models approximate the input-output behaviour of the plant as well as possible. However, the high-frequency dynamics that are left out of the model may influence the stability of the system. Therefore, a notion of maximum achievable bandwidth relative to the actual dynamics of the plant, is necessary for the motion control design and/or tuning. The challenge is to determine the highest achievable control bandwidth, given basic information about the lowest disregarded high-frequency dynamics.

A fundamental piece of information needed for the determination of the maximum controller bandwidth, is the resonance frequency, ω_e, of the lowest disregarded mode of the plant. Besides ω_e, information about any anti-resonance frequency, ω_a, is also crucial to determine the stability of the closed-loop system. The order in which ω_e and ω_a appear in the Frequency Response Function (FRF) and their relative distance play an important role in determining the extent of their interference with the stability of the closed-loop system [2].

Another important aspect is the damping in the plant. Damping becomes evident in both the phase and amplitude of high-order dynamics and generally contributes greatly to the stability of the system. Yet when designing a plant such as a high-precision industrial machine, damping is often overlooked. This is mostly due to the fact that it is difficult to model and control passive damping in a mechanical structure. In addition, damping is sometimes left out intentionally to improve accuracy and/or conservation of energy. However, damping can also be applied locally within a desired frequency range, by means of active control. The influence of damping on the stability of a closed-loop system justifies the effort put in the implementation of active damping. The scope of this paper concerns the role of damping in general.

AUTHORS' NOTE

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This publication is a reworked and extended version of a paper that has been presented at the 2010 IFAC Symposium on Mechatronic Systems held in Cambridge, Massachusetts, USA, September 13-15; see [1] and www.ifac-papersonline.net/detailed/45429.html.

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In this paper, the influence of both high-order dynamics and damping on the stability is investigated for P(I)D-controlled motion systems. PID controllers are broadly implemented in industrial applications. According to [3], over 90% of all control loops are of the PID type. PID controllers and the various tuning methods available are discussed extensively in literature, among others by [4], [5], and [6]. The tuning method used in this thesis is the one presented by [7], which uses the crossover frequency as the key tuning parameter. This tuning method has evolved from earlier formulations, such as [8], and [9].
First, a general plant model in which high-order dynamic characterization is embedded, is introduced. The motion control algorithm is presented along with the tuning rules that lead to the desired closed-loop performance. The final section deals with the influence of both viscous damping present in a plant, and the characteristics of the high-order plant dynamics, on the stability of the closed-loop system, in terms of a maximum achievable bandwidth.

Plant model

A dynamic model of the plant is assumed to be given in terms of a modal decomposition, which is an intuitive way of representing the dynamics of a system. In this section, a brief overview of modeling in modal coordinates is given. The reader is referred to [2,10,11] for more extensive information and theoretical background of modal analysis.

Modal modeling

A linear mechanical system without damping can be described by the following general equation of motion:

$$\boldsymbol{M}_x\ddot{\boldsymbol{x}}(t) + \boldsymbol{K}_x\boldsymbol{x}(t) = \boldsymbol{F}_x(t) \tag{1}$$

Here, $\boldsymbol{x}$ stands for the generalized displacements, and $\boldsymbol{F}$ for the generalized forces. $\boldsymbol{M}$ and $\boldsymbol{K}$, respectively, are the mass and stiffness matrix, which are in general non-diagonal. This set of equations can be decoupled by a transformation on the basis of the solution of the following eigenvalue problem:

$$(\boldsymbol{K}_x - \omega_{e,i}^2\boldsymbol{M}_x)\phi_i = 0 \tag{2}$$

which results in the eigenvalues of the plant, $\omega_{e,1}, \cdots, \omega_{e,n}$, and the corresponding eigenvectors or mode-shape vectors, $\phi_1, \cdots, \phi_n$. Both the eigenvalues and the direction of the eigenvectors are defined. For the length of the eigenvectors, various scaling methods can be used. The typical choice is scaling the length of each eigenvector such that it is equal to 1, $|\phi_i| = 1$.

To obtain a set of decoupled equations of motion, a coordinate transformation can be performed using:

$$\boldsymbol{x}(t) = \Phi\boldsymbol{q}(t) \tag{3}$$
$$\Phi = [\phi_1,\phi_2,\ldots,\phi_n]$$

This transformation results in the equation of motion in modal coordinates:

$$\boldsymbol{M}_m\ddot{\boldsymbol{q}} + \boldsymbol{K}_m\boldsymbol{q} = \Phi^T\boldsymbol{F}_x \tag{4}$$

where:

$$\boldsymbol{M}_m = \Phi^T\boldsymbol{M}_x\Phi \qquad \boldsymbol{K}_m = \Phi^T\boldsymbol{K}_x\Phi \tag{5}$$

Equation 4 has diagonal mass and stiffness matrices, which means that for $i \neq j$ the following orthogonality properties hold:

$$\phi_i^T\boldsymbol{M}_x\phi_j = 0 \qquad \phi_i^T\boldsymbol{K}_x\phi_j = 0 \tag{6}$$

and

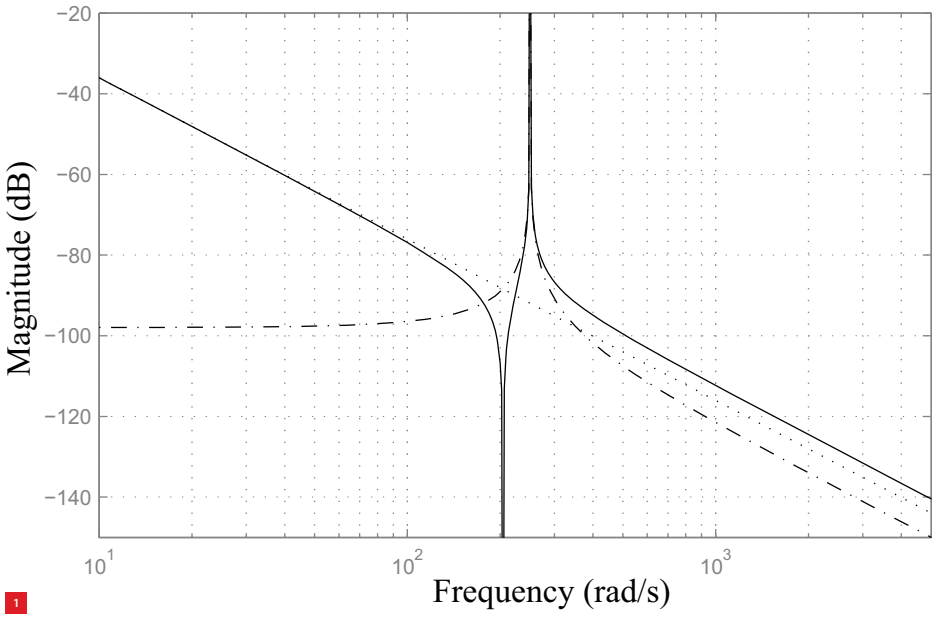
$$m_{m,i} > 0 \qquad k_{m,i} \geq 0 \tag{7}$$

So the equation of motion for the i-th mode is:

$$m_{m,i}\ddot{q}_i(t) + k_{m,i}\,q_i(t) = \phi_i^T\,\boldsymbol{F}_x(t) \tag{8}$$

Here, $m_{m,i}$ and $k_{m,i}$, respectively, represent modal mass and stiffness of the i-th mode. The transfer function from the local force $F_{x,j}$ (the j-th element of $\boldsymbol{F}_x$) to the local position x_k (the k-th element of $\boldsymbol{x}$) is the sum of each modal contribution, which in turn is determined by the mode-shape vector elements, ϕ_{ij} and ϕ_{ik}:

$$\frac{x_k}{F_{x,j}}(s) = \sum_{i=1}^{n}\frac{\phi_{ij}\phi_{ik}}{m_{m,i}\,s^2 + k_{m,i}} \tag{9}$$



1 *Magnitude plot: rigid body mode (dotted), first flexible mode at ω_e = 250 rad/s (dashed) and the resulting fourth-order plant transfer function (solid line).*

Furthermore, the resonance frequency of the i-th mode, $\omega_{e,i}$, is given by:

$$\omega_{e,i} = \sqrt{k_{m,i} \cdot m_{m,i}^{-1}} \tag{10}$$

Since the mechanisms leading to energy dissipation (damping) are complex, it is customary to include damping in the model by incorporating it functionally into the individual modes, instead of performing detailed modeling [12]. Including modal damping, $d_{m,i}$, into (9) yields the following transfer function:

$$\frac{x_k}{F_{x,j}}(s) = \sum_{i=1}^{n} \frac{\phi_{ij}\phi_{ik}}{m_{m,i}s^2 + d_{m,i}s + k_{m,i}} \tag{11}$$

Assuming a viscous model for damping, $d_{m,i}$ can be expressed in terms of the modal damping ratio, ξ_i, according to:

$$d_{m,i} = 2\,\xi_i m_{m,i}\omega_{e,i} \tag{12}$$

Incorporating (10) and (12) in (11) results in:

$$\frac{x_k}{F_{x,j}}(s) = \sum_{i=1}^{n}\left(\frac{1}{m_{m,i}} \cdot \frac{\phi_{ij}\phi_{ik}}{s^2 + 2\xi\omega_{e,i}s + \omega_{e,i}^2}\right) \tag{13}$$

Effective modal parameters

The value of modal parameters is not unique and depends on the chosen scaling method for the eigenvectors. By transforming the modal parameters into effective modal parameters, unique parameters can be obtained that do not depend on the scaling method and have physical meaning [2].

The effective modal parameters of the i-th mode in the physical Degree of Freedom (DoF) k can be calculated by:

$$\begin{aligned} m_{eff,i,k} &= m_{m,i}/\phi_{ik}^2 \\ k_{eff,i,k} &= k_{m,i}/\phi_{ik}^2 \\ d_{eff,i,k} &= d_{m,i}/\phi_{ik}^2 \end{aligned} \tag{14}$$

The effective modal parameter in the k-th DoF is basically how a modal parameter is perceived in the k-th DoF of the structure. For instance how a modal stiffness is perceived in the rotational DoF.

The transfer function (11) in terms of effective modal parameters becomes:

$$\frac{x_k}{F_{x,j}}(s) = \sum_{i=1}^{n}\left(\frac{\phi_{ij}}{\phi_{ik}} \cdot \frac{1}{m_{eff,i,k}s^2 + d_{eff,i,k}s + k_{eff,i,k}}\right) \tag{15}$$

Model reduction; fourth-order plant model

In order to simplify the plant model, model reduction is usually applied to high-order plant models. This results in a model having the rigid-body mode and lower-frequency modes that have a significant influence on the dynamic behavior of the plant in the frequency region of interest. In this paper we consider a fourth-order plant having a rigid body mode (i = 0) and a flexible mode (i = 1), as shown in Figure 1.

The transfer functions of this plant can be obtained using (11):

$$\frac{x_k}{F_{x,j}}(s) = \frac{1}{m_{m,0}s^2} + \frac{\phi_{1j}\phi_{1k}}{m_{m,1}s^2 + d_{m,1}s + k_{m,1}}$$

$$= \frac{1}{m_{eff,0,k}s^2} + \frac{\phi_{1j}}{\phi_{1k}} \cdot \frac{1}{m_{eff,1,k}s^2 + d_{eff,1,k}s + k_{eff,1,k}} \quad (16)$$

$$= \frac{(1+\alpha)}{ms^2} \cdot \frac{s^2 + 2\xi_a\omega_a s + \omega_a^2}{s^2 + 2\xi\omega_e s + \omega_e^2}$$

Here:

$$m = m_{eff,0,k}$$

$$\alpha = \frac{\phi_{1j}}{\phi_{1k}} \cdot \frac{m_{eff,0,k}}{m_{eff,1,k}} \quad (17)$$

In general, α_i is the factor relating $\omega_{e,i}$ and $\omega_{a,i}$ of the i-th mode of a plant according to:

$$\omega_{\alpha,i}^2 = \frac{\omega_{e,i}^2}{1+\alpha_i} \quad (18)$$

In a mechanical system, α is determined by the location of the sensor with respect to the actuator. For $\alpha > 0$, $\omega_{a,i}$ is smaller than $\omega_{e,i}$, implying that in the pole-zero plot there will be a pair of zeros between the rigid-body poles and the poles of the resonance. As α decreases, the zeros in the pole-zero plot move up along the imaginary axis towards infinity where they disappear, to appear again on the real axis when α decreases further [13, 14]. The position of the zeros with respect to the resonance poles determines the type of the plant transfer function. Table 1 shows different ranges of α and the corresponding types of plant transfer functions as discussed by [8], and [15]. Type N is not considered hereafter.

Motion controller

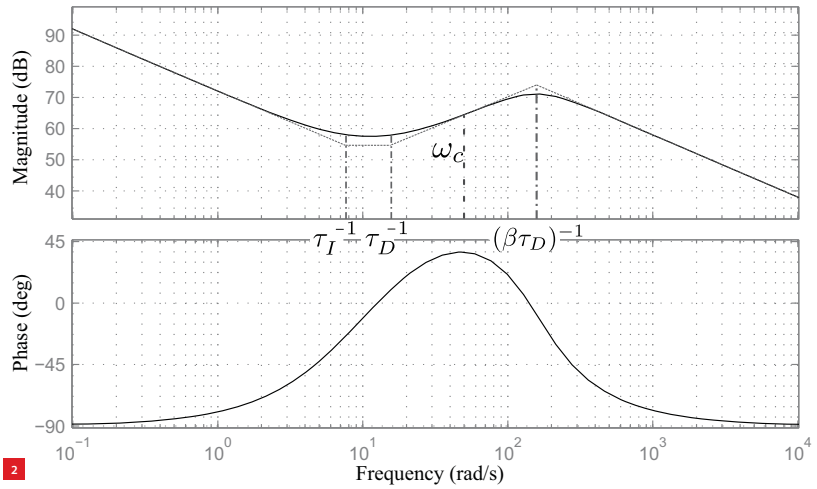
The motion controller is designed to have the minimum bandwidth that is required for the desired performance. The plant is assumed to be a moving mass (low-frequency approximation), the transfer function of which is given by:

Table 1 *Plant types.*

α	Plant type	Characteristic
$\alpha > 0$	Antiresonance - Resonance (AR)	$\omega_a < \omega_e$
$\alpha = 0$	Unobservable (U)	$\omega_a = \omega_e$
$-1 < \alpha < 0$	Resonance - Antiresonance (RA)	$\omega_a > \omega_e$
$\alpha = -1$	Resonance (R)	ω_a = inf
$\alpha < -1$	Non-minimum phase (N)	zeros at $\pm\omega_a$ on the real axis

$$P(s) = \frac{1}{ms^2} \quad 19)$$

The controller can be composed of various combinations of proportional (P), integral (I), and differential (D)



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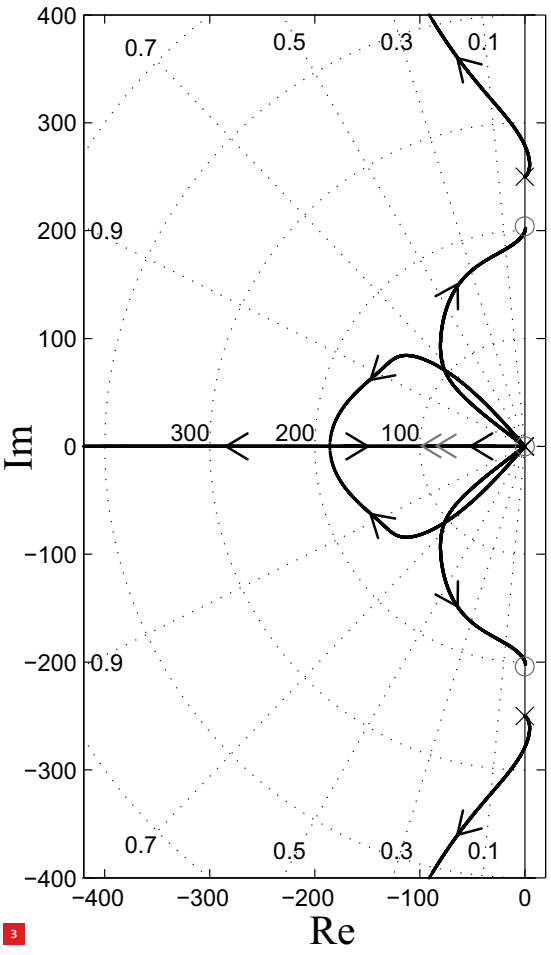

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2 *Bode plot of PID+ controller; $\tau_I = 2\tau_D$, $\beta = 0.1$, $\zeta = 0.7$, $m = 0.63$ kg and $\omega_c = 50$ rad/s.*

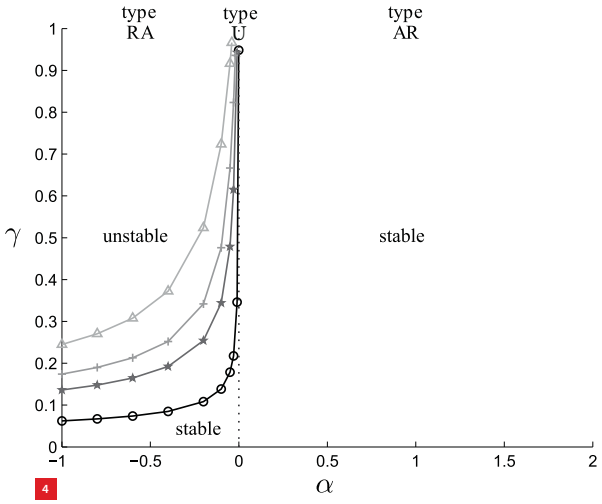
3 *Root-locus showing pole locations as a function of ω_c. Note that the two motion-control zeros move along the real negative axis for an increasing ω_c, as shown by the two gray arrows.*

components. To reduce the high-frequency gain, a low-pass filter can be added to the controller that adds extra high-frequency roll-off. The combination of all the above mentioned components is termed PID+, where the '+' sign refers to the additional low-pass filter. The PID+ controller in series form has the following general transfer function:

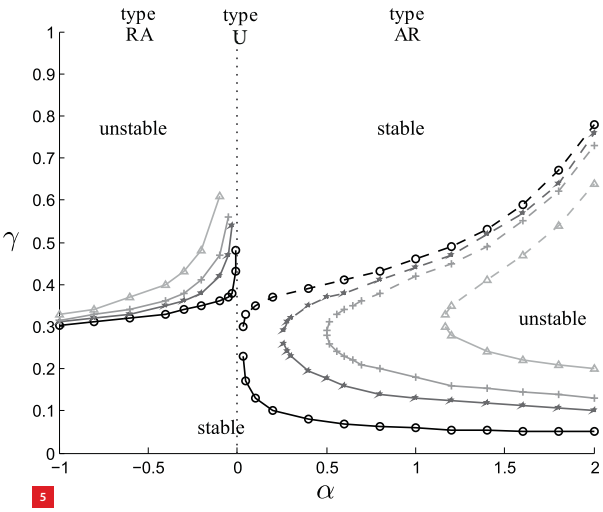
$$C_{PID+}(s) = k_p \cdot \left(1 + \frac{1}{s\tau_I}\right) \cdot \left(\frac{s\tau_D + 1}{(s\beta\tau_D)^2 + 2\zeta\beta\tau_D s + 1}\right) \tag{20}$$

$$= k_p \cdot \frac{(s\tau_D + 1)\,(s\tau_I + 1)}{((s\beta\tau_D)^2 + 2\zeta\beta\tau_D s + 1)\,s\tau_I}$$

where $\beta = 0.1 \cdots 0.3$ is the tameness constant of the differentiation action within the motion controller and $\zeta = 0.7 \cdots 0.9$ represents the relative damping of the second order roll-off filter. Figure 2 shows the Bode plot of a PID+ controller.



4 *Unstable regions; PID without high-frequency roll-off. Increasing ξ from dark to light; o: 0.1%, ⋆: 1%, +: 2%, Δ: 5%. Lower bound: solid line; upper bound: dashed line. Note: The stability regions plotted here also apply for the PD motion controller without high-frequency roll-off.*



5 *Unstable regions; PID+. Increasing ξ from dark to light; o: 0.1%, ⋆: 1%, +: 2%, Δ: 5%. Lower bound: solid line; upper bound: dashed line.*

$$k_p = m\omega_c^2\sqrt{\beta}$$
$$\tau_D = (\omega_c\sqrt{\beta})^{-1} \tag{21}$$
$$\tau_I \geq 2\tau_D$$

Hence, the central parameter by which performance and stability are tuned, is ω_c.
In most cases an encoder mounted on the motor is used for motion-control feedback. So the motion control is collocated. Yet, as a result of both the integral component and the low-pass filter, the motion controller is not passive and thus there is no guarantee for stability, despite the collocation of the actuator and sensor.

Stability analysis

Since the parameter used for tuning the motion controller is the desired ω_c, the stability analysis of the system is performed by looking at how it is influenced by variations in ω_c.

Method

The pole-zero plot of the system is used, where a root-locus [16] is obtained by increasing ω_c from 1 to ∞. (Setting the minimum value for ω_c to 0 will result in division by zero in the calculation of τ_D. Hence, on the basis of the plant dynamics, a sufficiently low value that is greater than zero should be chosen.) Note that this is in contrast with the conventional root-locus, where the loop gain is used as the variable to construct the loci with. Figure 3 shows the ω_c-based root-locus of the system consisting of the above mentioned plant (see (16) and Figure 1) and a PID+ motion controller (see (20) and Figure 2). Using this root-locus plot, a range of ω_c can be deduced, for which the closed-loop system is stable (16). It can be seen from Figure 3 that, due to the resonance poles, this system is unstable for low ω_c and that it becomes and remains stable when ω_c is increased. The latter is only valid under the assumption that no unmodelled high-frequency modes are present.

Stability; ω_c versus α versus ξ

For several values of damping, $\xi = 0.1\% \cdots 5\%$, the lower and upper bound of ω_c have been determined for which a system consisting of a fourth-order plant, described by [17], and a PID-type motion controller, as discussed above, is unstable. The results are depicted in Figures 4, 5, and 6, where γ (22) is plotted versus α (18).

$$\gamma = \frac{\omega_c}{\omega_e} \tag{22}$$

The lower bound in each plot is an indication of the maximum achievable bandwidth for which the corresponding closed-loop system is guaranteed to be stable. Uncertainty in plant parameters has not been

considered here. This means that the stability boundaries can be subject to shift as a result of discrepancies between the model and the plant. Yet the results can still be used as a rule of thumb, when designing motion controllers. Above the upper bound, should one be present, unmodelled modes may exist that can destabilise the system. Hence the stability in this region is uncertain.

PID

Figure 4 shows the stability regions of the PID motion controller, without high-frequency roll-off, which is described by:

$$C_{PID}(s) = k_p \cdot (1 + \frac{1}{s\tau_I}) \cdot \frac{s\tau_D + 1}{s\beta\tau_D + 1} \qquad (23)$$

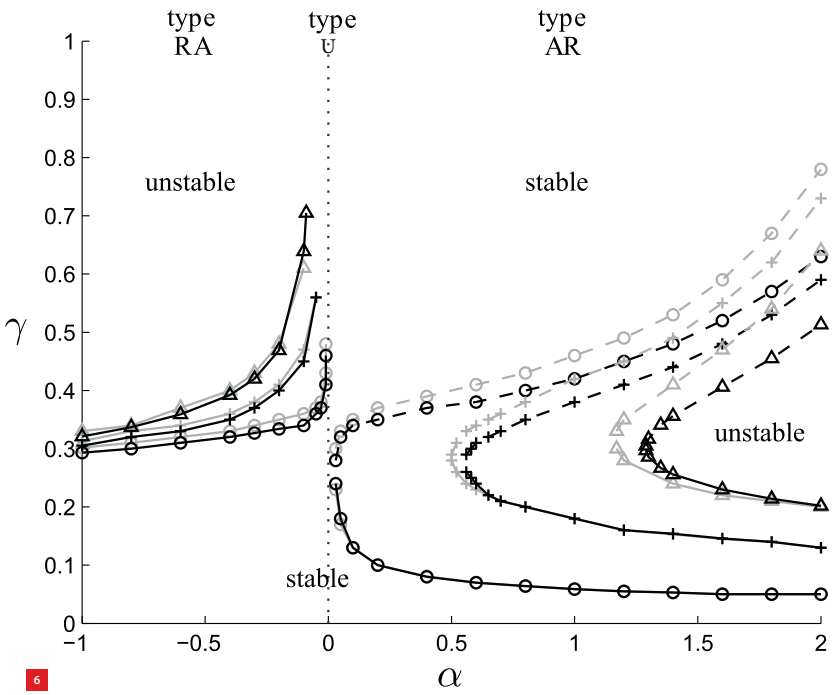
What strikes most is the poor stability of the RA-type plant transfer in contrast with the stability robustness of the AR type. Damping improves the stability of the RA type considerably, but in case of low damping, it is better to design the control loop such that the plant transfer is of the AR type.

Despite the advantageous stability properties of the AR-type plant transfer in combination with a PID motion controller, it could be undesirable, if not impossible, to implement it in practice. This could for instance be due to the noise present in the system, which in addition to being loud, can wear out the mechanics. More important is the limited dynamics of the actuator and sensor of the motion loop and the required anti-aliasing filter in case of digital control. Thus, having some sort of high-frequency roll-off is inevitable.

PID+

The stability regions for the PID+ motion controller (20) are shown in Figure 5. The first thing that catches the attention is that the lower bound of the RA-type transfer function is larger compared to that of the AR type. Looking at Figure 5, $\omega_c \leq \omega_e/3$ seems to be an appropriate rule of thumb for obtaining a stable closed-loop system for the RA type. As for the AR type, when $\xi = 0.1\%$, which is typically the case for high-precision industrial machines, γ should be well below 0.1.

For $\alpha = 0$, $\omega_e = \omega_a$ and the plant transfer function is equal to that of a moving mass. Since the motion controller is designed for this type of plant, the closed-loop system is stable around this point. The closer α is to zero, i.e. the smaller the distance between ω_e and ω_a, the larger the stable γ range (higher maximum ω_c). As damping increases, this region expands simultaneously with the elevation of the lower bound and, if applicable, the decrease of the upper bound of instability region. As ξ increases, the instability vanishes for a growing range of α. This effect is more noticeable for the AR-type plant, of which the lower bound of the instability region elevates significantly due to the increase of damping. The relative profit in terms of achievable ω_c is considerable.



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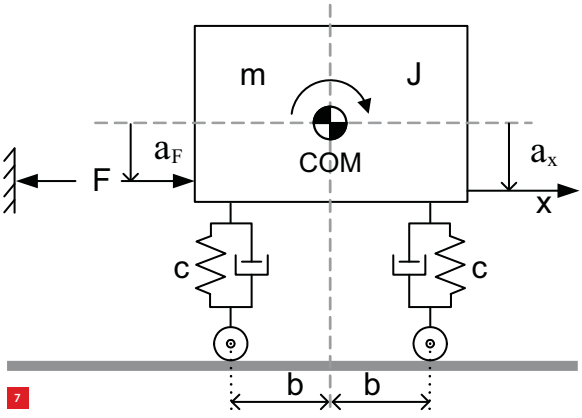
PD+

Figure 6 shows the stability regions for both the PID+ and PD+ motion controller. The transfer function of the PD+ controller is given by:

$$C_{PD+}(s) = k_p \cdot \frac{s\tau_D + 1}{(s\beta\tau_D)^2 + 2\zeta\beta\tau_D s + 1} \qquad (24)$$

The values considered for ξ are $\xi = 0.1\%$, $\xi = 2\%$, and $\xi = 5\%$. It can be seen that the unstable region for the RA type of plant transfer function expands over the entire α range.



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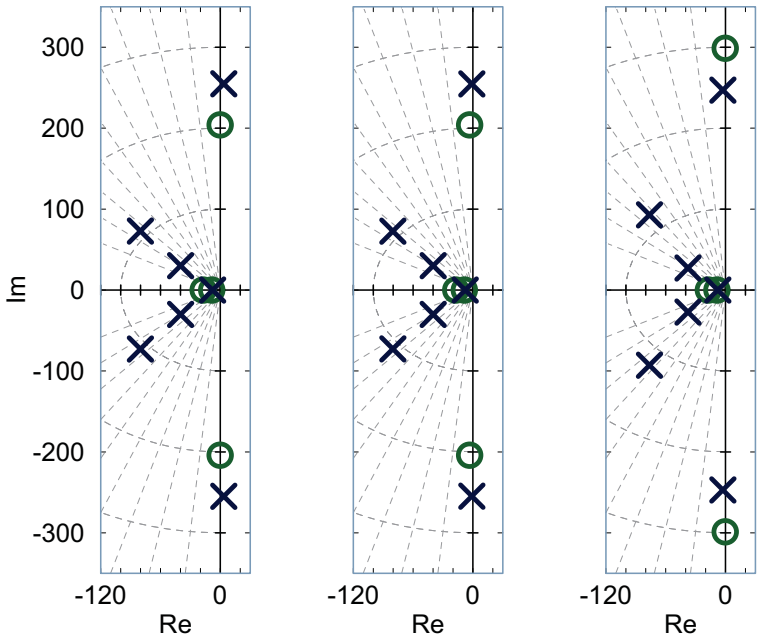
6 *Unstable regions; dark: PD+, light: PID+. o: $\xi = 0.1\%$, +: $\xi = 2\%$, and Δ: $\xi = 5\%$. Lower bound: solid line; upper bound: dashed line.*

7 *Schematic view of the positioning system.*



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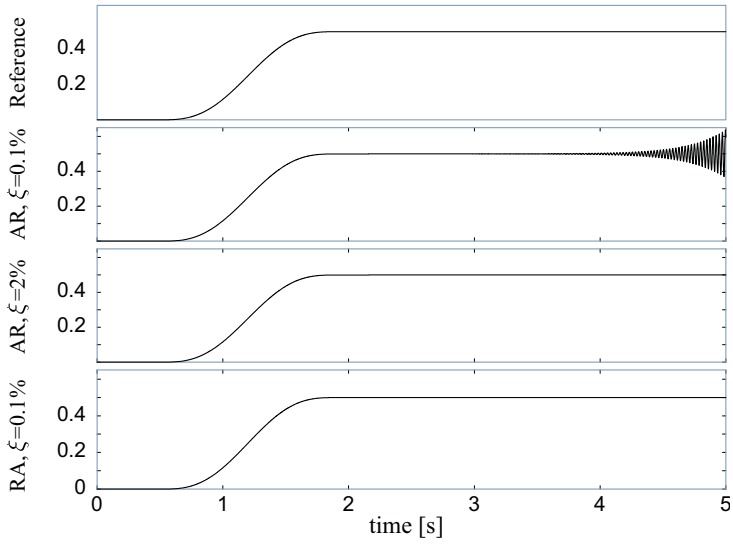
8 *Pole-zero plot of the closed-loop system. Left: AR-type plant, $\xi = 0.1\%$. Middle: AR-type plant, $\xi = 2\%$. Right: RA-type plant, $\xi = 0.1\%$.*

9 *Position (m) vs. time (s). Top: third-degree polynomial position reference signal. Second: position of the AR-type plant, $\xi = 0.1\%$. Third: position of the AR-type plant, $\xi = 2\%$. Fourth: position of the RA-type plant, $\xi = 0.1\%$.*

There is a small improvement due to higher damping visible close to the $\alpha = 0$ line, but the overall influence of damping is not significant for this type of transfer function.

As opposed to the RA type, the unstable region for the AR-type plants does decrease when no integration is applied in the motion control. This effect becomes more beneficial as α increases. Note that the gain in the stable region is largely due to the shift of the upper bound of the instability region. As mentioned before, the stability in this region may be influenced by the unmodelled high-frequency dynamics of the plant and thus, when the knowledge about the plant's high-frequency dynamics is limited, this γ range should be avoided. This makes the enlargement of the stable region less useful. However, at the edge of the instability region, for lower values of α, also the elevation of the lower bound contributes to the shrinkage of the instability region. The shift of this edge increases as modal damping grows.



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Application

Consider a positioning system consisting of a carriage, with $m = 0.63$ kg, on a linear motor, as depicted in Figure 7. The guideway of the linear actuator has a certain compliance, which results in vibrations in the transient response of the plant. The compliance is shown by means of two linear stiffnesses, indicated by c, in Figure 7. We are only interested in the displacement of the carriage in the x-direction. The force applied to the carriage, F, excites two modes [2]:

- *rigid body mode*, which is a translational movement in the x-direction;
  DoF: x, $m_{eff,0,x} = m$.
- [a] *rocking mode,* which is a rotation about the Center of Mass (CoM);
  DoF: ϕ, $m_{eff,1,\phi} = J$, $k_{eff,1,\phi} = 2cb^2$.

The resulting displacement of the carriage, x, is measured by a position sensor at the distance a_x from the CoM. The transfer function of the plant (see (16)), incorporating both the aforementioned translation and rotation, is given by:

$$\frac{x_k}{F_{x,j}}(s) = \frac{1}{m\,s^2} + \frac{a_F a_x}{J\,s^2 + 2\xi\sqrt{J\,k}\,s + k} \qquad (25)$$

$$= \frac{1+\alpha}{m\,s^2} \cdot \frac{s^2 + 2\xi_a\omega_a s + \omega_a^2}{s^2 + 2\xi_e\omega_e s + \omega_e^2}$$

Here, m represents the mass of the carriage, J its inertia, k is the rotational stiffness, and a_F and a_x are the relative positions of the actuator and sensor with respect to the CoM. For the damping in the plant, the viscous damping model has been used, resulting in the $2\xi\omega_e$ term in (25). Furthermore:

$$\alpha = \frac{m}{J} a_F a_x \qquad k = 2cb^2$$

$$\omega_e = \sqrt{\frac{k}{J}} \qquad \omega_a = \sqrt{\frac{k}{J + m a_F a_x}}$$

The guideway in this example causes a vibration mode at $\omega_e = 250$ rad/s. We assume this mode to be badly damped. Hence, $\xi = 0.1\%$ is used in the plant model, which is a typical value for ξ in high-precision machines [18]. The

measured displacement of the carriage, x, is used as the feedback to the motion controller. The position sensor is mounted such that $\alpha = 0.5$. Hence the plant has an AR-type transfer function.

The motion controller is a PID+, with $\beta = 0.1$ and $\zeta = 0.7$. The position reference signal is a third-degree polynomial with a maximum jerk of $j_{max} = 8$ m/s^3. The allowed set-point error is $e_{sp} = 1$ mm. For this type of motion controller in combination with a third-order set-point, the minimum value for ω_c, called ω_d, which is needed in order to stay within the required set-point error margin, can be determined using:

$$\omega_d^3 = \frac{2 \cdot j_{max}}{\beta \cdot e_{sp}} \qquad (26)$$

The aforementioned parameters of this positioning system lead to $\omega_d = 54$ rad/s, hence $\gamma = 0.22$. Figure 5 shows that this value of γ is located in the unstable region. The pole-zero plot shown at the left side of Figure 8 shows that the complex poles of the plant in the closed-loop system are located in the right-half s-plane.

If possible, the controller should be changed to the PID type, which will yield a stable system according to Figure 4. In case this is not possible, using Figure 5, it can be found that there are two options to stabilise the system.
The first option is to move the sensor, in other words change a_x, such that a pole-zero flipping occurs, as depicted in the right plot in Figure 8. The transfer function of the plant will then become of the RA type, which is stable for $\gamma = 0.22$. However, it might not be possible to relocate the sensor on the machine in such a way that this change in the transfer function type occurs.
The second option is to increase the damping of the vibration mode. Figure 5 shows that $\xi = 2\%$ is high enough to obtain a stable system. This results in the pole-zero plot in the middle in Figure 8. If passive means are not sufficient to reach this level of damping, active damping should be considered. Figure 9 shows the simulation results with both $\xi = 0.1\%$ and $\xi = 2\%$. The results are as predicted by Figure 5.

Conclusion

This paper has analysed the influence of various types of high-order dynamics on the stability of a closed-loop system, where the controller is tuned using a reduced model of the plant. Results have been summarized in Figures 4, 5, and 6. These figures show stable and unstable regions in terms of α (relating antiresonance, ω_a, to resonance, ω_e) and γ (relating tuning parameter ω_c to resonance ω_e) for varying relative damping of the resonance.

The maximum achievable open-loop crossover frequency, ω_c, which is directly related to the closed-loop bandwidth, can be deduced from these figures by using no more information than the α and ξ belonging to the most critical high-order dynamics. Hence, the results provide guidelines concerning the achievable ω_c, which can be used in the process of motion control design.

The results also show the beneficial effect of structural damping on the stability regions. The extent of the corresponding improvement depends on both the plant type and the type of motion controller. The best performance can be achieved for the AR type of plant transfer function with sufficient damping. ■

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MEASURING WITH 1 µN CONTACT FORCE

Stiff. That's what a conventional contacting stylus probe should be to function with high accuracy. But as a logical but unwanted consequence, the contact force between a stiff stylus and a workpiece is relatively high. Werth Messtechnik in Giessen, Germany, succeeded in designing and making a stylus with a glass sphere only 20 µm in diameter. The contact force between this sphere and the workpiece is only one micronewton. The Fibre Probe is one of the components of the Werth Multisensor system with many intelligent optical solutions for measurement problems.

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AUTHOR'S NOTE

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One of Werth Messtechnik's specialties is adding optical innovations to its high-precision measuring machines. Examples include the edge-detecting probing eye ("Tastauge"), integrated digital camera image processing, in-focus plane vertical sensing and low-contact-force workpiece sensing ("Fasertaster", Fibre Probe).

Werth was the first company to use the well-known medical computer tomography for measuring industrial objects in the Werth TomoScope. Thorough knowledge of a variety of optical and mechanical probes inspired Werth to introduce its Multisensor Technology, a modular system that integrates different sensors in one measuring unit. Such a Multisensor instrument can replace three or four conventional measuring machines.

1 *The 10 µm diameter Fibre Probe glass stylus with a 20 µm diameter sphere.*

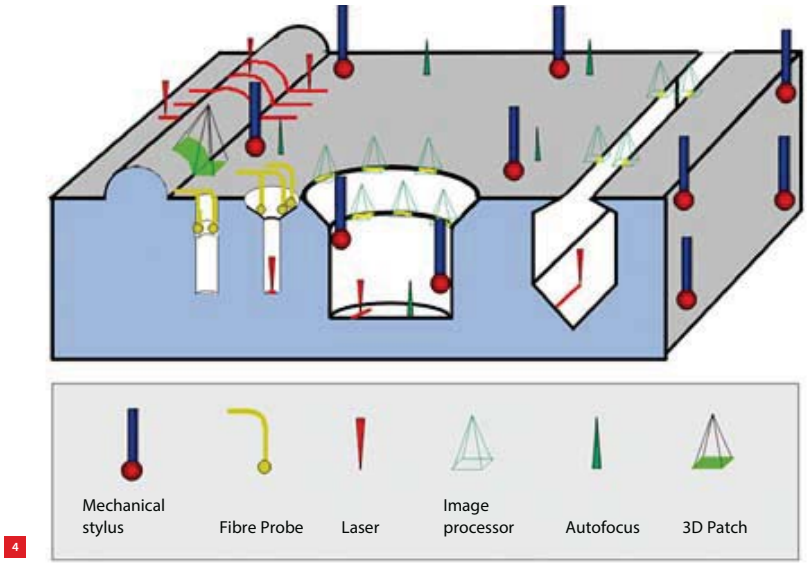
2 *The Fibre Probe measuring device. In the upper left corner the Renishaw adapter.*

The Fibre Probe

Why did Werth choose glass as the material for its Fibre Probe (Figure 1)? Because it is far more flexible than steel, carbon or tungsten and can bend further before it breaks. And thanks to its virtual lack of plasticity, it returns to its original shape after bending.

Werth succeeded in making a glass stylus sphere with a diameter of only 20 µm and an extremely thin glass fibre by applying a practical process: melting. When heating the end of a 10 µm diameter glass fibre, a droplet occurs. After solidifying, a perfect sphere appears, thanks to surface tension. After this manual process, the sphere has to be coated because of the required reflectivity. Werth predicts that stylus spheres of 10 µm will become available soon.

The difference between conventional measuring probes and Werth's Fibre Probe is the touch-triggering to zero. In a conventional probe this happens at the upper side of the stylus stem in the probe itself. In the Fibre Probe, however, this happens optically in the sphere, which eliminates the influence of the stem stiffness (see Figure 2).



Observing the sphere

The crux of the Fibre Probe is the application of vision. An optical semiconductor sensor in a camera observes the stylus sphere and determines its position in relation to the centre line of the optical system. Thus the camera determines the position of the sphere centre in X,Y coordinates of the measuring machine.

Working with transmitted light is preferred because of the better contrast between black and white. But this is not an option when measuring blind holes. Surface illumination might then be a possibility, but sometimes the blind hole is too small and too deep. In that case, one has to resort to light to be guided through the probe stem.

The Fibre Probe can measure extremely small bores such as diesel engine injection nozzles. Even if the bore is not perfectly vertical, the Fibre Probe will still function, because only part of the sphere needs to be visible. The contact force, extremely low thanks to the very flexible glass stem, is maintained by programming the slide movements with the nominal CAD contour. However, the Fibre Probe is also able to scan unknown contours. Another feature is exciting the probe with low-amplitude vibrations to eliminate stick-slip effects.

The impact of contact forces of conventional touching probes was found to be as much as 0.1 N [1]. When measuring a plastic object with a ruby sphere with a diameter of 130 µm, permanent deformations of the object with a depth of about 1 µm were observed. But when the Werth Fibre Probe was applied, there were no visible indentations at all.

More sensors

Multisensor Technology is the registered name for a modular system in which the basic measuring machine can be equipped with more than just one sensor [2]. One Werth machine can be equipped with non-contact and contact sensors, including fixed-focus optics, zoom optics, lasers, line lasers, confocal sensors, Renishaw touch-trigger styli, scanning probes and microprobes (see Figure 3). Therefore, the Werth machines are provided with universal kinematic adapters: from Werth for the optical sensors, from Renishaw for the mechanical probes.

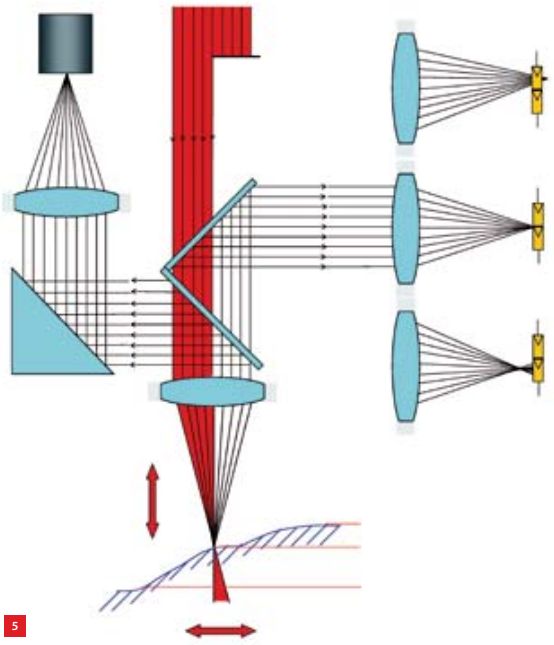
The big advantage of Multisensor Technology is the versatility of one Werth measuring machine. Instead of measuring a workpiece with a range of measuring instruments like a profile projector, a tactile measuring machine, a contour scanner or a measuring microscope, a Multisensor 3D CMM can fulfil the tasks of all these machines. This makes measuring more flexible and faster. It is also more accurate thanks to elimination of the time-consuming realigning on successive instruments. And generally buying only one machine means a smaller investment.

Figure 4 illustrates the measurement of a relatively complicated workpiece and the various (six!) sensors selected to each fulfil a measuring task in the most accurate and efficient way. These sensors are discussed in more detail below.

Mechanical stylus

Renishaw is the renowned supplier of mechanical sensors. The trigger moment depends on an electrical contact, a piezoelectric element or a strain gauge. Modern 5-axis

3 *A Werth Multisensor coordinate measuring machine (CMM) equipped with different sensors.*
4 *The sensors needed to inspect a complicated workpiece.*



5 *Vertical laser sensor according to the Foucault knife-edge method. The signal of a differential photo diode (right) is used for the vertical position determination or for measuring a surface profile in a short range.*

touching systems are so large that they require extra space in the Z direction, also because the probe has to be retracted from deep holes.

Fibre Probe

This sensor was described above. The probe fits in a Renishaw adapter (see Figure 2).

Laser

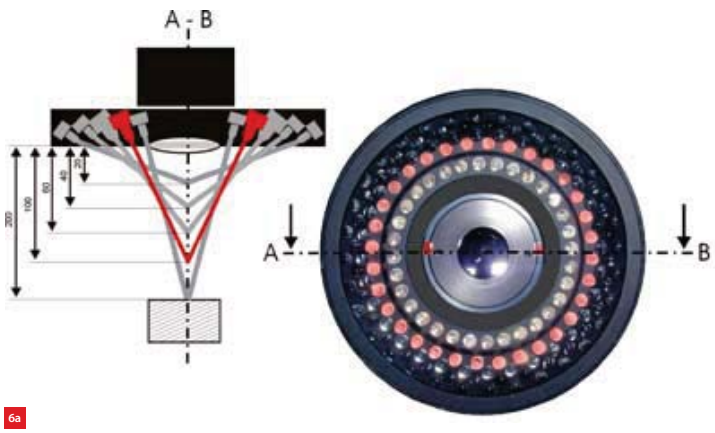
Werth applies various laser measurement techniques. Already in the eighties it used a TTL laser (Through-The-Lens) with a fixed-focus objective. Nowadays, both zoom and fixed-focus optics can be equipped with a TTL laser in a system based on the Foucault knife-edge principle. The Werth vertical laser adjusting system is derived from Foucault's original method (for testing the form accuracy of lenses and mirrors). The knife edge is located in the beam path and is being imaged onto the object (see Figure 5). A differential photo diode delivers a position evaluation signal. This system provides faster scanning results than conventional triangulation systems for vertical position definition.

Image processor

In an image processing system, measurements take place in the object image created on a semiconductor sensor consisting of a fine matrix of light-sensitive pixels. One of the problems of such a system is the definition of a high-resolution contour line around or in the object. How to interpolate between individual pixels was recently discussed in Mikroniek [3], so here only certain unique optical features introduced by Werth will be dealt with.

Measuring an object requires first finding the relevant area. This means the imaging system has to have a low magnification. But during the actual measuring procedure a high magnification and thus a small optical window is needed to optimally benefit from the sensor resolution. Another aspect is the need for a variable working distance to prevent collisions between the objective and the workpiece. All this calls for a zoom objective, but traditional zoom objectives suffer from play and position uncertainty of the movable intermediate lens. Werth solved this problem by developing a motorised zoom lens system with accurately guided moving lenses. Some zoom systems are able to reach a working distance up to 200 mm, eliminating the need for a high vertical measuring range as with mechanical probes.

Although transmitted illumination is preferred for reasons of optimal contrast, reflective illumination has to be used sometimes. When applying a TTL reflective-light system



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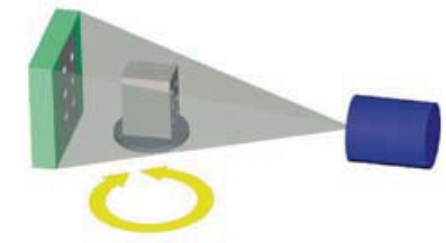
6b

6 *The Werth MultiRing reflective illumination system with concentric rings with different light-exit angles to achieve maximum image contrast.*
(a) Schematic.
(b) Realisation.



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7 *In X-ray computer tomography, an X-ray point source generates an image on a flat X-ray sensor. The object rotates to let a computer calculate a 3D image from successive 2D images on the sensor.*

8 *The Werth TomoScope HV Compact, a Multisensor CMM with X-ray computer tomography.*

9 *The Werth ScopeCheck measuring machine in the Koni quality department.*

the image becomes bright: bright-field illumination. But for accurate measurements, a better contrast can be reached by applying dark-field illumination, in which the reflecting light strikes the object in an oblique direction (see Figure 6a). The Werth MultiRing system of concentric rings (Figure 6b) with different light-exit angles makes it possible to select a striking angle with maximum image contrast.

Autofocus sensors

When glass or other shiny surfaces have to be measured, the usual optical sensors won't work. Then the confocal Werth CFP (Chromatic Focus Probe) is a better solution. Its working principle is that when using white light, the spectrum of the reflected light depends on the wavelength-dependent refraction on the more or less transparent surface. Further, the spectrum of the reflected light depends on the distance of the surface to the focal plane of the lens. Thus, by analysing the chromatic spectrum of the reflected light, a vertical reference can be derived. The working distance is relatively short, but the system is suited for measuring optical objects like lenses with submicron accuracy.

Another accurate non-contact measuring method for focussing in the Z direction used by Werth is the NanoFocus system [4]. NanoFocus has a partnership with Werth. In NanoFocus systems a Nipkow disk with 160,000 diaphragms is used to scan a surface in the Z direction.

3D Patch

In a 3D Patch sensor a moving camera performs an autofocus process for a large number of measuring points of successive cross-sectional lines described in a curved surface.

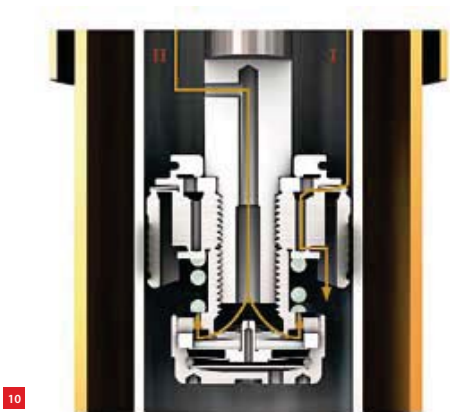
X-ray computer tomography

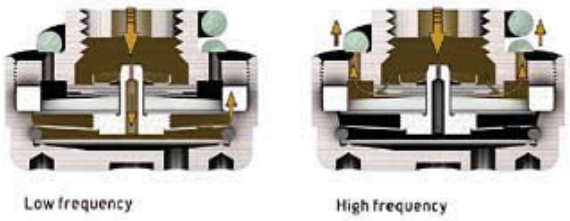
In Mikroniek we have already described the many advantages of X-ray computer tomography (CT), especially when it comes to looking inside objects [5]. Figure 7 recapitulates the basic principle. Obviously, in industrial CTs, the object rotates, unlike medical computer tomography where the human body does not move. Based on 2D images from various rotational positions, a 3D image can be calculated by applying a complicated computer algorithm. Dimensions of hidden holes and the fitting of internal parts can thus be measured and checked. Moving the workpiece in relation to the X-ray sensor changes the magnification.

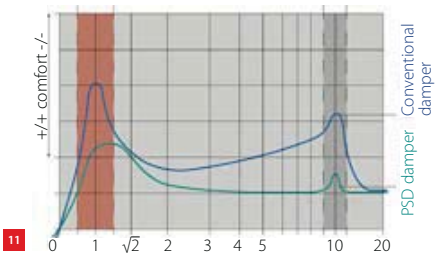
Werth is not the only producer of industrial CT measuring instruments. But Werth is unique in combining X-ray CT with its Multisensor technique. Werth even succeeded in patenting this combination, just like other inventions in industrial CT technology. Nowadays machine accuracies better than 5 µm are achieved. Most X-ray Multisensor measuring machines are fitted with a granite base frame with two separate axes, which serve to move the X-ray sensor and the tactile sensor, respectively. Figure 8 represents a complete measuring instrument with the required shielding for X-ray safety.

Practice

Koni (head office in Oud Beijerland, the Netherlands) is a renowned designer and manufacturer of innovative shock absorbers. Obviously, the quality laboratory plays an important part in the engineering and manufacturing procedures. The measuring room is fitted with the usual range of measuring instruments, including a large CMM and contour and roughness instruments. Recently, Werth installed a ScopeCheck measuring machine with a range of







10 *The Koni FSD system for shock absorbers with different oil flow paths and thus adapted damping characteristics for low and high frequencies.*

11 *Damping diagrams for Koni FSD shock absorbers (green) and conventional absorbers (blue).*

400 x 200 x 200 mm³ in the Koni quality department (see Figure 9).

Arvid op den Kelder, head of the department, explains that this measuring machine replaces nearly all his other measuring equipment, thanks to the Multisensor Technology. He shows the measuring of precision parts of the FSD (Frequency Selective Damping) shock absorber system. This system ensures different oil flow paths and thus adapted damping characteristics for low and high frequencies in car shock absorbers (see Figure 10). It solves the problem of compromising between comfort and driving safety characteristics. The system ensures optimal adaptation to low frequencies (car movements due to braking, curving and accelerating) and high frequencies (road surface conditions) (see Figure 11).

The tolerances for the various FSD parts are specified in the 10 µm range and should therefore be inspected with a measuring instrument with micron-range accuracy. After programming a measuring cycle with the easy-to-use WinWerth software, the actual measurements require no more than a few minutes.

To conclude

About forty years ago the touch-probing technique was invented. For quite a long time this was the only CMM sensor technology available. But CMMs with mechanical touching probes have certain disadvantages, especially now that difficult tasks in measuring small elements such as holes, chamfers and edges become common practice. Having to move a relatively large touching probe in and out of deep holes calls for a volumetric working range much larger than the dimensions of the workpiece. And the negative effects of relatively high contact forces cannot be ignored.

Werth Messtechnik succeeded in applying sophisticated optical principles to overcome these disadvantages, with a 1 µN measuring contact force as a nearly unbelievable highlight. Note that the various Multisensor Technology components can be individually selected to achieve a custom-built measuring instrument. ■

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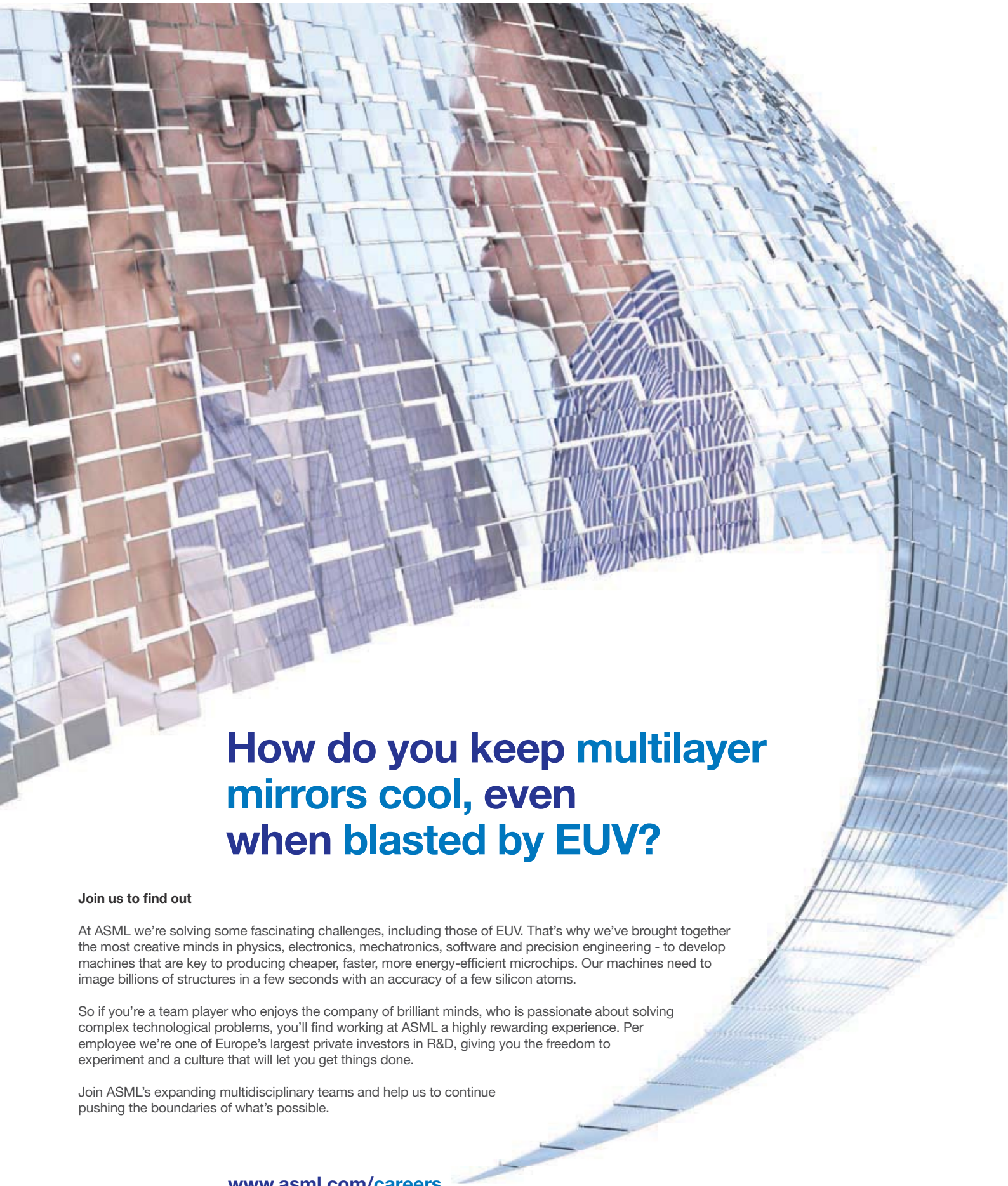

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For engineers who think ahead

JOINT INITIATIVE OF DSPE, LIS ACADEMY AND THE HITTECH GROUP

At the recently held Holland High Tech Event, representatives from the Dutch high-tech industry emphasised the need for combining forces to stimulate export growth in the coming years. Well-trained engineers are essential to supporting these ambitions, including their know-how on manufacturability. These days, however, graduates of bachelor's and master's degree programmes in precision engineering have limited knowledge of manufacturability. This article outlines the relevance of manufacturing knowledge of young professional engineers and presents the joint Summer School on Manufacturability initiative.

ERIK KNOL AND PIETER KAPPELHOF

In the Netherlands, higher education programmes have strong track records in precision engineering (e.g. motion control, opto-mechatronics, and also ultra-high and ultra-clean vacuum technologies). However, the current bachelor's and master's programmes in precision engineering pay rather limited attention to manufacturability and production technologies. Of course, new and innovative technologies such as ALM (additive layer manufacturing) or ECM (electrochemical machining) are addressed. But, it is more important to educate students in manufacturability in relation to widely and intensely used metal-oriented manufacturing technologies such as milling, turning, and casting. These technologies should be a major part of the knowledge base of young professional engineers.

AUTHORS' NOTE

Erik Knol is the manager of LiS Academy in Leiden, the Netherlands, as well as owner of Qeam business consultancy in Leiden. Pieter Kappelhof is Department Manager Development at Hittech Multin in Delft, the Netherlands, which is part of the Hittech Group, and also a DSPE board member.

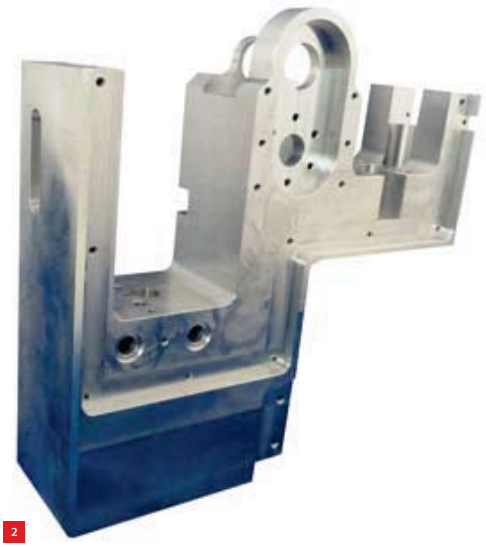
Relevance of expertise

The relevance of know-how on manufacturability of young professional engineers is expressed by means of "design for manufacturability" (DfM). DfM "involves the simultaneous considering of design goals and manufacturing constraints in order to identify and alleviate manufacturing problems while the product is being designed, thereby reducing the lead time for product development and improving product quality" [1]. We feel the need to indicate that good DfM practice is facilitated when young professional engineers experience manufacturability. In our opinion, theoretical knowledge and tools such as "Computer Aided Manufacturability Analysis" should be complemented with real-life demonstrations and practice.

Summer School

DSPE acknowledges the importance of improving the knowledge of young professional engineers on manufacturing technology. Therefore, it has initiated a Summer School on Manufacturability organised by and held at the LiS (*Leidse Instrumentmakers School*, Leiden Instrument Makers School). The LiS's involvement is exemplary for the drive to strengthen its vocational education programme in precision technology and enhancing its activities in engineering projects for and with students (LiS Engineering) and in professional courses (LiS Academy).

Recently, the Dutch national government rewarded the LiS with a 5-year grant for its educational plans in a public private partnership collaboration with parties such as Hittech Multin, Demcon, Medtronic BRC, TNO, TU Delft and VUmc. The summer school perfectly matches LiS Academy's scope and facilities for the education of professionals.



1 *Optics table in a PCB (printed circuit board) mask printer; an example where redesign from a machined into a casting product led to cost reduction and increase in performance. (Photo courtesy of Hittech Group)*

2 *Precision component manufactured by milling. (Photo courtesy of Hittech Group)*

3 *Stainless steel frame made by metal sheet working. (Photo courtesy of Suplacon)*

Metal working

The summer school is a five-day course (27-31 August 2013) in Dutch for young professional engineers with limited manufacturability know-how. Milling, turning, grinding, electro-discharge manufacturing (EDM), casting and sheet metal working are the technologies presented and discussed. Many of these technologies have been used for centuries, but nevertheless are still evolving in terms of accuracy, materials that can be processed, or speed of production.

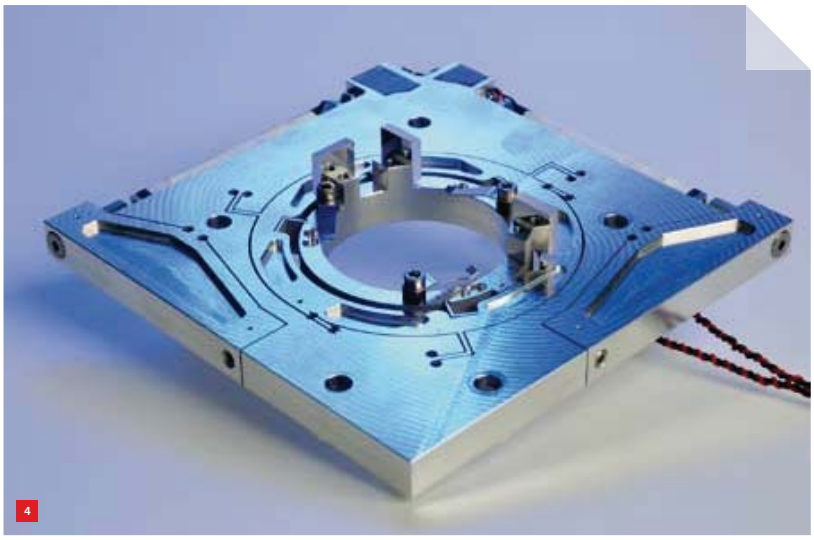
Casting and sheet metal working may be applied less in the manufacture of low-volume and high-complexity products such as photolithography machinery and electron microscopes. Most Dutch universities of technology and universities of applied sciences no longer educate students in casting and sheet metal technologies. Nonetheless, these technologies generally offer unknown possibilities for the production of complex products and in some cases lead to cheaper or faster production compared to other technologies.

The purpose of the summer school course is to provide in-depth insights into manufacturability rather than offering a general overview. For this reason, the current course skips topics such as etching, ALM or component production from new materials (including ceramic or fibre-reinforced products) and focuses on milling, turning, grinding, EDM, casting and sheet metal working.

Company visits

Hittech Gieterij Nunspeet, in Nunspeet, the Netherlands, will be visited for a casting lecture and to see metal casting in practice. Casting is a technology of economic interest for small series of about 20 objects. Applications have shown that casting is a relevant, simple manufacturing alternative to reach, for example, higher stiffness, lower weights, lower unit costs, fewer assembly steps, and greater freedom of design.

In addition, Suplacon in Emmeloord, the Netherlands, will be visited for an in-depth lecture and guided tour with demonstrations in sheet metal manufacturability. Sheet metal production is known for its cost reduction possibilities compared to other production techniques and is often presented as a means to “light and stiff” design. It is not often used on a smaller scale, mainly due to lack of knowledge.



4 *Scan stage for an electron microscope, as an example of an EDM-manufactured product. (Photo courtesy of Hittech Group)*

Course programme

On each course day, one or two production technologies will be explained to participants in three ways as shown in the table below.

Morning lectures will focus on manufacturing aspects and relate them to design and engineering processes. These lectures will be given by LiS, TNO, Hittech Group, Hembrug and other organisations. Participants will learn basic design rules and their history. What is the draft angle of a casting product? What is the relationship between bending angle versus sheet metal thickness? When to use wire-cut EDM, taking into account slit widths and wire thickness?

In the afternoons, these techniques will be demonstrated in practice or experienced by the participants themselves. Milling, turning and EDM will be demonstrated at the LiS, and casting and metal sheet working during the company visits.

Finally, in the evenings, informal group discussions will be facilitated by senior experts (in research instrument making, production engineering, etc.). Participants will be encouraged to share examples of their own work experience. This interactive, friendly setting gives the participants the opportunity to refine their "lessons learned" on manufacturability.

Presentations, background material and manufacturability rules "you always wanted to know" will also be made available.

More steps to follow

The summer school is a small step in the process to enhance the knowledge on manufacturing techniques among young professional engineers. More initiatives to exchange knowledge in this field are very welcome. It is essential to continuously improve the awareness of manufacturability in order to design and produce products with higher added value at competitive prices. ■

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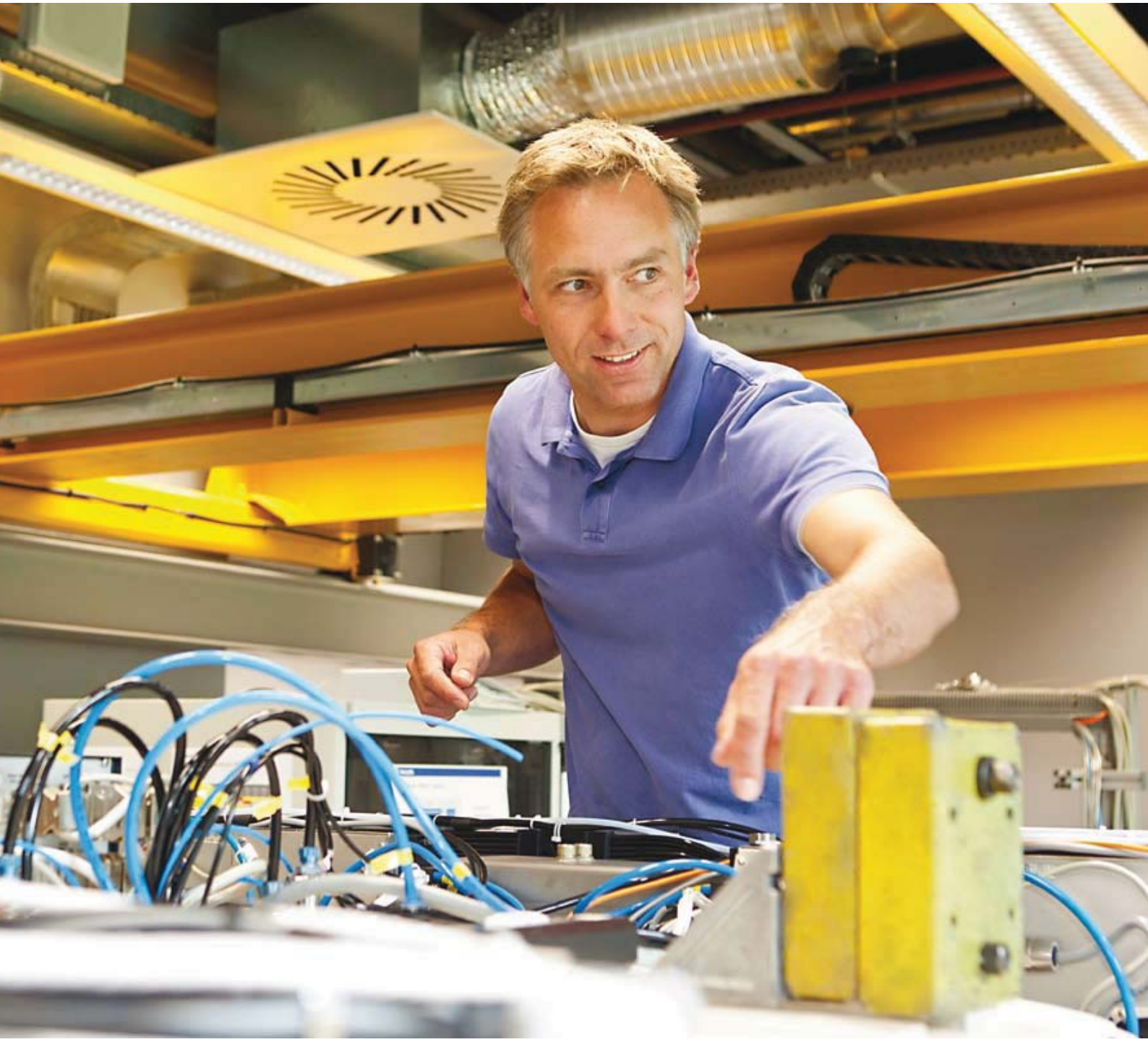
Preliminary schedule for the Summer School on Manufacturability (27-31 August 2013).

Day	Tuesday	Wednesday	Thursday	Friday	Saturday
Location	**LiS (Leiden)**	**LiS (Leiden)**	**Hittech Gieterij Nunspeet (Nunspeet)**	**Suplacon (Emmeloord)**	**LiS (Leiden)**
Technologies	Milling and turning (introduction)	Milling, turning and grinding (advanced)	Metal casting	Metal sheet working	EDM
Morning	Introduction and lectures by LiS and Hittech Group	Lectures by TNO and Hembrug	Lectures by Hittech Gieterij Nunspeet	Lectures by Suplacon	Lectures by LiS
Afternoon	Manufacturing demonstrations and practice	Lectures, manufacturing demonstrations and practice	Lectures, excursion and casting practice	Excursion and manufacturing demonstrations	Manufacturing demonstrations
Evening	Group discussions with senior experts	Group discussions with senior experts	Social event	Group discussions with senior experts	



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PHILIPS

CRISIS, WHAT CRISIS?

While the economy at large may be in crisis, the high-tech industry is booming like never before and businesses continue to hire new staff. ASML is a fine example. To boost the influx of technical talent, new initiatives such as traineeship programmes are being explored. It's in this context that Yacht, a 'supplier' of highly trained interim professionals, is launching a programme for technical trainees.

ASML, the global market leader for lithography machines, is known for the cyclicity of its business, which is typical of the semiconductor industry, but is not related to the economic situation per se. At present, i.e. during this period of economic turmoil, the company has a record number of more than 10,000 staff working around the world. Of that number, 7,000 or so work in the Netherlands, in Veldhoven and now also in Oischot since the company took over Wijdeven Motion. There are 4,850 permanent staff and more than 2,000 temporary staff. This record is the result of a co-investment programme launched by ASML in July last year which saw 1,200 job openings created, amongst other things. By mid-March, 800 of these openings had been filled, says Jojanneke Meewis-Strijbos, Senior Labor Market Communications Specialist at ASML.

1 *ASML is still dying for new staff.*

Development opportunities

ASML is still dying for new staff and its relatively low rate of employee turnover of a little over 3% clearly helps. So people like staying at ASML, and as far as Meewis is concerned that's got nothing to do with the crisis ("playing it safe and staying put"). "It's related to the content of their work, our high-quality technology, and the challenges that they won't get anywhere else. What's more, we offer our staff a lot of development opportunities, vertical, horizontal and diagonal throughout the organisation, for instance from Development & Engineering to Customer Support or Industrial Engineering. Using the 'Career Tracks' system, people can actively manage their options themselves."

Multinational

ASML is still very successful at finding good staff in the Netherlands – despite the low technical education outflux – both for junior and senior level positions. But 30% of recent new hires in Veldhoven are from abroad, from countries such as Belgium, Ireland, Italy, Spain, India and China. That's quite an increase when compared with previous years, says Meewis. "In the past year, we have hired 50 nationalities, and in Veldhoven we now have more than 80 nationalities working for us."

2 *ASML is trying to improve the male-female ratio of its staff.*

From temporary to permanent

Given the abovementioned cyclicity of its business, ASML retains a relatively large layer of temporary staff. That allows the company to maintain a permanent basis while also giving it some breathing space."Since 2000, we have not had to let go of anyone with a permanent contract. And last year we even gave 250 temporary staff a permanent contract", Meewis says, hoping to disprove any negative impressions.

Recruitment task

Meewis and her colleagues are now facing the task of recruiting a further 400 staff, which will undoubtedly be followed by even more work. Currently, it's mechatronic engineers that are in high demand. The recruitment process utilises a range of tools. Campus promoters are a new phenomenon at ASML; these are students who have a job on the side for ASML to promote companies at their university by way of in-house events, lunchtime seminars, etc. This was launched at the three Dutch universities of technology earlier this year. At the end of April, there will be a two-day PhD event in Veldhoven, which is designed to drum up interest in ASML's technology among those still working on their PhD at university. It goes without saying that ASML uses social media to promote the company and the technology, but where recruitment is concerned, personal face-to-face contact remains key. Given the number of international candidates, Skype is proving to be a good solution.

INFORMATION

WWW.ASML.COM

Technology promotion

In addition to direct recruitment, ASML does a lot of technology promotion with a view to the future. As part of this, school groups come to visit Veldhoven, ASML engineers teach guest lessons at schools and there's a special Girls Day for mothers and daughters. The male-female ratio is still a bit one-sided, Meewis admits, with 11% of employees being women. "That said, 17% of our new hires were women."

Traineeship

A new initiative to make ASML even more attractive as an employer is a traineeship programme that ASML is now developing. This programme is for junior-level candidates who will be doing a three-year programme, after one year of which they can specialise in the role of technical expert or manager. "They can try out different departments, take technical courses and train in presentation and consultancy techniques, for example." ■

Technical trainees

Yacht, a 'supplier' of highly trained interim professionals, has expanded its services. In close collaboration with clients, including Philips Healthcare, Yacht is now also recruiting technical trainees for major companies. Yacht is primarily looking for trainees with a Master's in Electronics, Mechatronics, Mechanics or Software. According to a Yacht press release, its programme of training courses and coaching means that these young technical engineers get off to a flying start on the job market.

The technical trainees will participate in the intensive Young Technical Professional Program. They follow a three-year training programme at the client's and at Yacht, and during these three years they develop from engineers into lead designers. They can then grow into key positions in the fields of Architecture, Project Management or Management Leadership in the client's Research & Development department.

Yacht is targeting technical trainees because there is a high demand for highly trained technicians and a limited pool. As such, searching for, finding and retaining technical talent is a major challenge nowadays for employers, believes Yacht. The trainees are employed by Yacht for the duration of the three-year programme, and once the programme is finished, the clients are ensured of an influx of technical talent from the bottom up.

WWW.YACHT.NL

PRECISION IN BUSINESS DAY: VSL

On 28 March 2013, just before the deadline for Mikroniek's April issue, a Precision in Business (PiB) day was held at VSL, the national metrology institute of the Netherlands, based in Delft. The theme of the PiB day, which included presentations and a lab tour, was: the ultimate in accuracy!

Sound and reliable measurement is VSL's core activity. In many industries, product development and optimisation processes require very accurate measurements, for which VSL maintains and develops the national standards. In that capacity, VSL supplies industry and governments with absolute accuracy that can always be traced directly back to the national measurement standards.

After a general introduction to VSL, presentations were given on the meter and its traceability, the ultra-precise form characteristics of optical surfaces and 3D microparts, and the metrological characteristics of microvesicles from body fluids.

The forthcoming June issue of Mikroniek will include an extensive report of the PiB day. ■

WWW.VSL.NL

Invitation **Launch optics & optomechanics interest group DSPE**

DSPE has decided to create an optics & optomechanics interest group, which will focus on sharing knowledge about optical and optomechanical design. These topics gain more and more relevance for precision engineering in the Dutch high-tech systems industry. DSPE will strive to connect to European and other international initiatives. The interest group is highly recommended by prominent optics specialists in the Netherlands.

The interest group will be launched on 24 April, 16:15 h, at booth C104 during High-Tech Systems 2013 in Eindhoven.

Interested? Mail to info@dspe.nl

CPE COURSE CALENDAR

COURSE	CPE points	Provider	Starting date (location, if not Eindhoven)
BASIC			
Mechatronic System Design (parts 1 + 2)	10	HTI	10 June 2013 (part 1) 11 November 2013 (part 2)
Construction Principles	3	MC	15 May 2013 29 October 2013 (Utrecht)
System Architecting	5	HTI	4 November 2013
Design Principles Basic	5	HTI	29 May 2013
Motion Control Tuning	6	HTI	20 November 2013
DEEPENING			
Metrology and Calibration of Mechatronic Systems	2	HTI	18 November 2013
Actuation and Power Electronics	3	HTI	23 September 2013
Thermal Effects in Mechatronic Systems	2	HTI	7 November 2013
Summer school Optomechatronics	5	DSPE + HTI	24 June 2013
Dynamics and Modelling	3	HTI	25 November 2013
Specific			
Applied Optics	6.5 6.5	MC HTI	12 September 2013 29 October 2013
Machine Vision for Mechatronic Systems	2	HTI	26 September 2013
Electronics for Non-Electronic Engineers	10	HTI	3 September 2013
Modern Optics for Optical Designers	10	HTI	13 September 2013
Tribology	4	MC	29 October 2013 (Utrecht)
Introduction in Ultra High and Ultra Clean Vacuum	4	HTI	28 October 2013
Experimental Techniques in Mechatronics	3	HTI	to be planned
Design for Ultra High and Ultra Clean Vacuum	4	HTI	25 November 2013
Advanced Motion Control	5	HTI	7 October 2013
Cooling of Electronics Workshop	3	HTI	29 May 2013
Iterative Learning Control	2	HTI	4 November 2013
Advanced Mechatronic System Design	6	HTI	to be planned

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.DSPEREGISTRATION.NL/LIST-OF-CERTIFIED-COURSES

Course providers

- The High Tech Institute (HTI)
  WWW.HIGHTECHINSTITUTE.NL
- Mikrocentrum (MC)
  WWW.MIKROCENTRUM.NL
- Dutch Society for Precision Engineering (DSPE)
  WWW.DSPE.NL

UPCOMING **EVENTS**

24-25 April 2013, Eindhoven (NL)

High-Tech Systems 2013

New event building on Hightech Mechatronica, the trade fair and conference that Techwatch has been organising since 2007. See page 46 ff. for the official High-Tech Systems 2013 catalogue.

WWW.HIGHTECHSYSTEMS.NL

25 April 2013, Eskilstuna (SE)

Robotics Innovation Challenge

Event organised by Robotdalen, a Swedish robotics initiative with the mission to enable commercial success of new ideas and research within robotics & automation.

WWW.ROBOTDALEN.SE/RIC2013

22-23 May 2013, Veldhoven (NL)

Vision, Robotics & Mechatronics 2013 / RoboNED Conference 2013

The 12th edition of the Vision & Robotics trade fair and conference has been expanded into Vision, Robotics & Mechatronics. Once again it will be combined with the RoboNED conference (on Tuesday 22 May 2013). Vision, Robotics & Mechatronics targets everyone in the Netherlands and Belgium active in the fields of vision, robotics, industrial automation and mechatronics. RoboNED, as one of the Dutch ICT Innovation platforms, coordinates robotics activities in the Netherlands.

VISION & ROBOTICS mechatronics

ROBONED Conference

WWW.VISION-ROBOTICS.NL
WWW.ROBONED.NL

27-31 May 2013, Berlin (DE)

Euspen 13th International Conference and Exhibition

Conference topics will include:

- Renewable Energy Technologies (progress enabled by precision engineering advancements)
- Nano & Micro Metrology
- Ultra Precision Machines & Control
- High Precision Mechatronics
- Ultra Precision Manufacturing & Assembly Processes
- Important/Novel Advances in Precision Engineering & Nano Technologies

WWW.BERLIN2013.EUSPEN.EU

29 May 2013, Arnhem (NL)

VCCN Cleanroom Symposium and 16th Contamination Control

Symposium and trade fair organised by the Dutch Contamination Control Association (VCCN).

WWW.VCCN.NL

4-5 June 2013, Veldhoven (NL)

Materials 2013, engineering & technology

New trade fair, with exhibition and lecture programme, targeted at product developers, constructors and engineers to inform them on materials innovations and applications.

MATERIALS 2013

WWW.MATERIALENBEURS.NL

12 June 2013, Den Bosch (NL)

Bits&Chips Hardware Conference 2013

Event organised by Techwatch, targeting developers, decision makers, professionals, technical managers and buyers in the high-end electronics, advanced systems and IC development industry.

WWW.HARDWARECONFERENCE.NL/EN

24-28 June 2013, Eindhoven (NL)

International Summer school Opto-Mechatronics 2013

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

Summer school Opto-Mechatronics Precision Technology

WWW.SUMMER-SCHOOL.NL

27-31 August 2013, Leiden (NL)

Summer School Manufacturability

A joint initiative of DSPE, LiS Academy and the Hittech Group. See page 30 ff for a full article.

WWW.LISACADEMY.NL

Formal start to Mechatronics Academy

After a period of informal collaboration in the field of mechatronics training, marketed through The High Tech Institute (HTI), Maarten Steinbuch (a TU Eindhoven professor), Jan van Eijk (owner of MICE consultancy and professor emeritus at TU Delft) and Adrian Rankers (CTO Mechatronics, HTI) recently formalised their collaboration by establishing the Mechatronics Academy.

Their goal is to safeguard the continuity of the mechatronics-related training programmes that originated at Philips, and to expand and update the framework for these courses to satisfy the ongoing need for advanced high-tech education. Their philosophy is that excellence in any mechatronic development project can only be achieved by a team of the best experts with in-depth knowledge of their own field, basic understanding of related fields, a collaborative attitude and skills.

For open training programmes, the Mechatronics Academy will collaborate exclusively with The High Tech Institute. This fits in with HTI's growth scenario, focused on marketing, communication & promotion and collaborating with a growing number of prominent content partners in the various fields. The Mechatronics Academy (MA) can also organise in-company training on request.

The MA training portfolio includes Design Principles, Dynamics & Modelling, Advanced Motion Control, Thermal Effects in Mechatronics Systems, and many more. The Thermal Effects in Mechatronics Systems course enjoyed a successful debut in Eindhoven in March. The two-day course was developed by the MA together with specialists Theo Ruijl of MI-Partners and Jack van der Sanden from Philips Innovation Services. The course, which is part of the CPE certification scheme (see page 38), covers the theory and practice of the loss of precision in high-tech systems due to thermal loads from internal (motors, electronics, process heat) and external sources (operators, environment). Participants learn to estimate thermal effects, perform simulations and apply compensational techniques. This course is in demand because internal thermal loads increase in many advanced precision machines, while specifications for acceptable deformations (due to thermal effects for instance) become tighter.

WWW.MECHATRONICS-ACADEMY.NL

New European 450 mm project

Last month saw the launch of a three-year collaborative research project called Enable450. The project aims to co-ordinate European equipment and materials activities concerning the transition to 450 mm diameter wafers. The European Union project is intended to address standards setting and also to support the much larger ENIAC EEM450PR project which plans to help build a 450 mm pilot line in Leuven, Belgium. This pilot line is intended to provide Europe with a platform for 450 mm capable equipment and potentially for sub-10 nm process development.

Enable450 project participants include Intel Performance Learning Solutions (Leixlip, Ireland), ASML, ASM International, Applied Materials Israel and Recif Technologies. Wafer supplier Soitec is also involved, as are the European research institutes IMEC, Leti and Fraunhofer. Completing the project team are the European wing of industry body SEMI and consultancy Future Horizons. "450" will be subject of various presentations at High-Tech Systems 2013.

(source: Dutch High Tech Systems)

WWW.DUTCHHTS.NL

Twenty years of IBS Precision Engineering

On Friday, 22 March 2013, IBS Precision Engineering celebrated its 20th anniversary. 200 guests representing 70 companies visited IBS headquarters in Eindhoven, the Netherlands. IBS Precision Engineering provided some interesting project and product demonstrations during the celebration and reception. The highlight, however, was having Dutch astronaut André Kuipers as guest speaker. Kuipers shared his impressive experiences before, during and after his trip to the International Space Station.

In business since 1993, IBS Precision Engineering is a high-tech and innovative company offering a range of products and services in the field of precision engineering, metrology and high-end mechatronic applications. The products and services range from high-precision capacitive & inductive measuring systems and precision air bearings to complex machines and engineering (R&D) solutions.

WWW.IBSPE.COM

■ *The Isara 400 ultra-precision coordinate measuring machine, a showpiece of precision engineering at IBS, features an unprecedented ratio of measurement volume vs. measurement accuracy: 400 x 400 x 100 mm³ measuring volume vs. 45 nanometer measuring uncertainty in all three directions.*

THE OPTIMUM FLEXURE LINEAR GUIDANCE

The errata below refer to the above mentioned paper, Mikroniek 53 (1), pp. 5-11, 2013, and, partly, came up thanks to feedback from the readers.

RIEN KOSTER

1) Page 8, column 2, second paragraph, units should read N/m: c_{lat} = 12·10^6 N/m, and 2.4·10^6 N/m.

2) Expression 12 should read: $p = \frac{\hat{z}^2}{2l}$

3) Figure A4, horizontal axis, variable should read: $\zeta = z/t$

4) Relevance of the longitudinal stiffness of the central part of a flexure according to Figure 9.
Expression A10 regarding the phenomenon of stiffness drop of the flex bar in its longitudinal direction, at increasing excursion of the guided body, as derived in the appendix, is correct under the assumption that the central part of the bar is fully rigid both in terms of bending and in its longitudinal sense.

If the embodiment of a flex bar is performed, according to Figure 10, then, as far as bending is concerned, the stiffness of the central part will surely predominate that of the flexible part to such an extent, that the assumption is sufficiently fulfilled. However, in a case such as Figure 10, where the area of the cross section of the "rigid part" (A_m) is not predominating over the area of the cross section of the flexible part (A), the aforementioned assumption is not fulfilled. In this case the ratio A_m/A has to be estimated as not more than equal to 2. Additionally, taking into account the lengths of the rigid versus the flex parts, (5/6)l versus (1/6)l, a correction on the expression of the compliance, according to A10, needs to be made.

Obvious was that in the case of high longitudinal stiffness of the central part

$$\frac{c_{xx}(0)}{c_{xx}(z)} = \frac{1}{\mu(\phi, \varsigma, \alpha)}$$

$$c_{xx}(0) = \frac{EA}{2q} \qquad \text{(A10)}$$

The longitudinal compliance of the central part is equal to

$$\frac{1}{c_{xxm}} = \frac{(5/6)l}{EA_m} \qquad \text{(A11)}$$

The overall longitudinal compliance is the result of the addition of the compliant elements A10 and A11.

$$\frac{1}{c_{xx}} = \frac{1}{c_{xx}(z)} + \frac{1}{c_{xxm}}$$

$$\frac{1}{c_{xx}} = \frac{1}{\mu.c_{xx}(0)} + \frac{1}{c_{xxm}}$$

$$\frac{1}{c_{xx}} = \frac{2q}{\mu.EA} + \frac{5q}{EA_m}$$

If A_m is the cross sectional area of the central part and A that of the flex parts, the expression for the overall longitudinal compliance ($1/c_{xx}$) is rewritten as

$$\frac{c_{xx}(0)}{c_{xx}(z)} = \frac{1}{\mu} + \frac{2.5}{\beta}$$

$$\frac{1}{\mu} = \frac{c_{xx}(0)}{c_{xx}(z)} \quad \text{(A10, original article)}$$

$$\beta = \frac{A_m}{A}$$

$$c_{xx}(0) = \frac{EA}{2q}$$

$$q = l/6 \qquad \text{(A12)}$$

THE NETHERLANDS INSTITUTE FOR NEUROSCIENCE – MECHATRONICS FOR BRAIN RESEARCH

NIN (the Netherlands Institute for Neuroscience) researches a wide range of topics relating to the brain and vision. It's a lively, interdisciplinary institute that includes the Mechatronics department, which is one of the key facilities helping researchers stay abreast of the latest developments. A small team of mechanical, electronic and optical engineers provides a wide range of support services, from long-term projects (over one year) to all those quick fixes that researchers need instantly.

With new combinations of MRI and optogenetics having become available in recent years, brain research has developed by leaps and bounds. Rapid developments in the treatment of brain diseases such as dementia and Parkinson's hold the promise of a better quality of life for those afflicted. One example is deep brain stimulation. This is effective in treating the heavy tremors that seriously hinder patients with Parkinson's disease. The treatment involves planting electrodes inside the patient's brain. Optogenetics is a vital key to understanding the underlying mechanisms: by modifying specific brain cells to make them photosensitive, they can be switched on and off with light. This enables scanning the function of specific cells in relation to the tasks of that part of the brain.

The more advanced projects include developing techniques for MRI scanning and so-called hyperdrives: complex miniature electrode manipulators holding up to 16 adjustable electrodes within a bundle of just over 1.5 mm. Microscopes are frequently used in the workshop for precision lathe and assembly work.

A hyperdrive; see text for explanation.

Currently, NIN's mechanical workshop is a conventional "old school" workshop. Although modern techniques like 3D printing and laser cutting are frequently used, they are insourced. Incorporating new in-house technologies within the confines of an overpopulated building is a challenge (NIN is housed in the Academic Medical Center in Amsterdam). However, the institute has acknowledged the need for innovative technical support and has committed itself to embracing new technologies.■

Outside the box

One of NIN's oldest and most experienced engineers will retire soon, so there is a vacancy for a versatile creative precision engineer who enjoys interacting with researchers and translating ideas into new designs and prototypes. With the constant demand for new solutions, NIN is looking for someone who likes to think and work "outside the box".

j.brand@nin.knaw.nl (Joost Brand)

INFORMATION

WWW.HERSENINSTITUUT.KNAW.NL

INDUSTRIAL ADDITIVE MANUFACTURING

HIGH TECH
HIGH PRECISION
HIGH COMPLEXITY

TNO is a leading institute in Additive Manufacturing. It initiated a shared research programme comprising the entire value chain.

penrose

BRIDGING THE GAP
BETWEEN RESEARCH AND COMMERCIALISATION

TNO innovation for life

TNO.NL

FOCAL VISION AND OPTICS – MEASUREMENT SYSTEMS FOR INDUSTRY

Focal Vision and Optics designs and delivers optical measurement systems for use in a variety of industrial applications. These systems could either be OEM modules that will be further integrated into complex devices or single systems to be used for quality precision inspection.

In all cases, the optical measurement systems provide reliable and reproducible complete optical inspection results. They often replace sample-based and/or human eye inspection and contribute to process optimisation and cost reduction for Focal's customers.

Quality precision inspection may concern products or samples made of:

- sheet metal or cast steel;
- flat or shaped glass;
- plastic and rubber;
- agro-organic material;
- fabrics;
- human tissue.

In industrial production environments, in-line optical measurements and inspections are carried out for two purposes:

- detection of defects or anomalies on the inspected item;
- metrology: accurate shape measurement in 2D or 3D on the object scaled down to the micro-domain.

The specialists at Focal develop high-end hardware and software for both types of inspection, and combinations thereof. At Focal, we can offer the unique combination of optical system engineering expertise and advanced machine vision programming as well as artificial intelligent system design.

Depending upon the nature of inspection, the first step in system design consists of defining the most appropriate illumination strategy. Design choices will be evaluated and established for either coaxial illumination, back light, dark field or strobed high-intensity illumination, for the type of light sources (LED, halogen, plasma, etc.), and for filtering and polarisation. Some applications require wavelength-specific illumination, e.g. UV, visual light, near or far infrared. Focal has an optical laboratory with measurement equipment and various lab set-ups allowing its engineers to perform sample and sensitivity tests.

The next stage in optical inspection system design is the definition of algorithms for the images and type of measurement required. Focal's machine vision engineers prefer to use MVTech's Halcon software for implementing the measurement algorithms, but other programming languages, e.g. OpenCV or even C++ code, may be used as well. In most cases, a generically developed platform is chosen for user interaction, PLC communication and logging and monitoring during the final delivery of the optical measurement system. Focal's approach of using modular building blocks for obvious generic functions and developing application-specific robust algorithms for specific items ensures short development and roll-out cycles. ■

CONTACT

For more information and/or an assessment of specific optical measurement and/or inspection questions:
robert.evers@focal.nl

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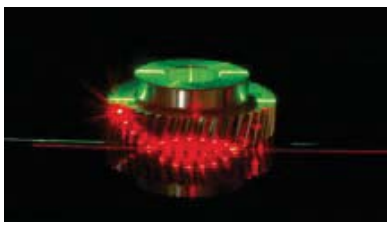


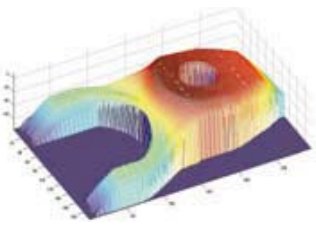

JOINING FORCES FOR HIGH-TECH SYSTEMS 2013

Two years ago, the Intelligent Community Forum selected the Brainport area as the smartest region in the world. In my opinion, one of the most important reasons for this success is the Dutch way of doing business. Some might say we are too blunt, too direct, and that we don't have respect for our superiors. But I consider it one of our biggest advantages. It creates a culture where every engineer with a good idea has the opportunity to step into the office of his boss and make his case. Such an atmosphere is a boost for innovation.

In general, the Dutch don't suffer from the "not invented here syndrome". We embrace open innovation, co-development and cooperation. Traditionally, Dutch entrepreneurs are outward-oriented, looking to create successes in a cooperative manner by realising win-win situations with partners. Outsourcing development work, even as far as risk-sharing and farming out complete (sub)modules, is the road they choose on their way to innovative new machinery and systems. Because of that there is a big community of OEMs and first- and second-tier suppliers, with a firm base in and around Eindhoven and equally important major branches in the Randstad area, Twente, Leuven (Belgium) and Aachen (Germany).

The most striking example of cross-border innovation is the tight partnership between ASML, the largest supplier of photolithography equipment in the world, and Carl Zeiss, the German manufacturer of optical systems. The chip machines from Veldhoven wouldn't be such a resounding success if it weren't for the perfect fit with Zeiss optics. It's obvious that ASML can only keep up with Moore's law while there is continuous deliberation and in-depth communication with the developers at Zeiss. We are honoured that both companies will join forces in a combined presentation at High-Tech Systems 2013. Together they will kick off a unique session of lectures about co-development. Others presenting their innovative partnerships include Philips Research, the German machine developer Süss Microtec, Mapper Lithography, the French research institute Leti, Atomic Layer Deposition specialist SoLayTec and the software development house Sioux.

That's one of the key words for High-Tech Systems anyway: partnership. First of all, the initiative for this conference and exhibition is a joint effort by Brainport Industries, DSPE, FMTC, Syntens and Techwatch. Secondly, we are proud to have a broad network of affiliated national and international partners. Even the biggest sponsorship of High-Tech Systems is by cooperation: Frencken, NTS and VDL-ETG joined forces to support our event. Co-development should also be in the back of your mind when you come to Eindhoven. When you keep your eyes and ears open, opportunities will present themselves.

While attending High-Tech Systems you can also pay a visit to the Model-Driven Development Days, a seminar dedicated to model-based design and simulation. On Thursday, there will be three side events about piezo technology (SmartPie), service business (B2B Service Business) and sensors (Sensing Matters). Also, you can meet your new (international) business partner at a matchmaking organised by Enterprise Europe Network, and your new boss at the recruitment plaza. So, if you haven't done it already, clear you schedule on 24 and 25 April for High-Tech Systems 2013.

Alexander Pil
Editor in chief, Mechatronica&Machinebouw (published by Techwatch)
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www.mechatronicamachinebouw.nl

HIGH-TECH SYSTEMS

OFFICIAL CATALOGUE – High-Tech Systems 2013

GENERAL INFORMATION

Opening hours
Exhibition and conference

Wednesday 24 and Thursday 25 April 2013
Exhibition floor 09:00-17:30 h
Conference programme 09:15-17:00 h

Parallel to High-Tech Systems 2013 the Model-Driven Development Days 2013 will be organised; your entrance ticket is valid for both events. See www.hightech-events.nl/mdd.

Registration

Registration is free of charge when completed before 19 April 2013. Your entrance ticket is valid for both days. With the ticket you can attend both High-Tech Systems 2013 and the Model-Driven Development Days 2013. Your registration gives you access to all presentations and the exhibition floor on both days. In addition, coffee and tea will be provided free of charge on both days.

Preregistration is possible until 19 April via www.hightechsystems.nl/en/visitors/registration.

After registration, you will receive a digital entrance ticket, which you need to bring to the event on 24 and/or 25 April 2013. At the registration desk you will receive your badge upon showing your entrance ticket. Registration after 19 April is only possible at the registration desk at the venue. Then an entrance fee of € 30 (VAT included) will be charged. Notice: You can only pay *cash*.

Organisation

High-Tech Systems 2013 is organised by Techwatch, publisher of Mechatronica&Machinebouw and Bits&Chips, Snelliusstraat 6, 6533 NV Nijmegen, the Netherlands.

Information

Conference programme: Alexander Pil, alexander@techwatch.nl or +31 24 3503534.
Other questions: events@techwatch.nl or +31 24 3505544.

Location

High-Tech Systems 2013 and the Model-Driven Development Days 2013 will be held in the heart of the high-tech region Brainport at the Klokgebouw (in hall A to C, and hall D, respectively), which is easy to reach by car, train or plane. The venue is one of the historic Philips buildings oozing technological heritage.
Address: Klokgebouw 50, 5617 AB Eindhoven, the Netherlands.

The Klokgebouw, venue for High-Tech Systems 2013.

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INITIATORS

Techwatch

Techwatch is a young publisher that produces two leading technology magazines, Mechatronica&Machinebouw and Bits&Chips. The company organises events for highly educated professionals and decision makers in the high-tech industry. Due to its independent media platform and events, Techwatch plays a crucial role in the industry by providing strategic information and linking people and companies.

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Brainport Industries

Brainport Industries was established so suppliers can join forces to strengthen the professional character and competitive position of the high-tech supply chain. As partners, suppliers can contribute to the continuity and growth of the high-tech industry and work toward achieving the ambitions set out in Brainport 2020. Brainport Industries provides a fertile ground and a solid structure for collaborative projects, whether they are related to technology, markets or people. It's an environment that provides for a continuing flow of knowledge workers and experts and enables suppliers to increase their output and steadily grow into market leaders.

Brainport Industries
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Syntens

Syntens stimulates organisations to renew themselves in a sustainable way and thereby increases the welfare and well-being in the Netherlands. Syntens raises awareness among entrepreneurs on their possibilities to innovate and helps them to make the steps that will lead to their goals. The wide and personal network Syntens maintains contains knowledge partners, entrepreneurs and branch organisations and stretches to the most important sectors of the Dutch economy. It is regionally available and accessible. This way, the performance of Syntens Innovation centre indirectly contributes to the extra revenues of hundreds of millions of euros for Dutch companies.

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DSPE

Independent branch organisation since 1957 for all precision engineers in the Netherlands, stimulating professional contact and sharing knowledge and experience. DSPE is *the* professional community for precision engineers: from scientists to craftsmen, employed from laboratories to workshops, from multinationals to small companies and universities.

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Flanders' Mechatronics Technology Centre

FMTC was founded by Agoria, the Belgian technology industry federation, and leading mechatronic companies in Flanders. It is a member organisation with the mission to jointly develop and utilize mechatronic competences to strengthen the competitive edge of the member companies and of the Flemish manufacturing industry. To achieve its mission, FMTC conducts industry-driven joint projects and contract research assignments in the following research programmes: smart sensors, self-optimization of mechatronic systems, energy efficient electro-mechanical drive-lines, and model-based design of mechatronic systems. As a technology demonstrator FMTC developed the first badminton robot in the world.

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SUPPORTERS

Wednesday 24 April 2013

CO-DEVELOPMENT

9:15-9:30	Opening
9:30-10:30	Jos Benschop, ASML, and Wolfgang Rupp, Zeiss **ASML-Zeiss, a successful partnership enabling Moore's law**
10:30-11:30	Break
11:30-12:30	Guido de Boer, Mapper Lithography, and Serge Tedesco, Leti **Development infrastructure of the Mapper lithography tool**
12:30-14:00	Lunch
14:00-15:00	Marc Verschuuren, Philips Research, and Ulrike Schoembs, Süss Microtec **From research to production - Transfer of in-house developed nano-imprint technology from Philips Research to Süss Microtec**
15:00-16:00	Break
16:00-17:00	Ronald van Dijk, SoLayTec, and Robert Hendriksen, Sioux **How modular system architecture and software simulators enable short time to market**

AUTOMOTIVE

11:30-12:00	Reimar Pfeil, ACCM **RF-based local positioning for autonomous driving**
12:00-12:30	Menno Beenakkers, DAF Trucks **Advanced drive-off control strategy for trucks**
12:30-14:00	Lunch
14:00-14:30	Rolf Slatter, Sensitec **Getting magnetoresistive sensors to Mars and further**
14:30-15:00	Siegfried Silber, LCM **More efficient high-performance permanent magnet machines in automotive**
15:00-16:00	Break
16:00-16:30	Sander Kemna, Inmotion **Finishing the 24H of Le Mans with an electric car**
16:30-17:00	Bert Dexters, Flanders' Drive **Functional safety engineering methodology for automotive and off-highway vehicle**

MEDICAL SYSTEMS

9:30-10:00	Heike Vallery, TU Delft **Robots to help humans walk and balance**
10:00-10:30	Philippe Malcolm, Ghent University **A simple pneumatically powered exoskeleton can reduce the metabolic cost of walking**
10:30-11:30	Break
11:30-12:00	Eric Smeets, Philips Healthcare **Motion challenges in a medical environment**
12:00-12:30	Jos Meuleman, Moog Robotics **Lopes II – the design of a rehabilitation robot for walking**
12:30-14:00	Lunch
14:00-14:30	Hernes Jacobs, Demcon **A close look on advanced eye surgery**
14:30-15:00	Bastian Deutschmann, DLR **DLR Mirosurge – A robotic system for research in telesurgery**
15:00-16:00	Break
16:00-16:30	Erik van Oene, Focal **Motion-controlled arm support**
16:30-17:00	Loretta van Kollenburg, HybriScan Technologies **Unique analytical high-tech platform in correlative imaging**

Subject to change.

Thursday 25 April 2013

SEMICONDUCTOR TECHNOLOGY

9:30-10:00	Dirk Tjepkema, Demcon **Active hard mounts: the future vibration isolation for lithography machines?**
10:00-10:30	Bas van Nooten, ASMI **450 mm: Opportunities for the European E&M industry?**
10:30-11:30	Break
11:30-12:15	Doede Kuiper, ASML **450 mm, a new challenge in mechatronics systems development**
12:15-14:00	Lunch
14:00-14:30	Per Carlqvist, Micronic Mydata **Twin tables in Micronic Mydata's LDI 5S**
14:30-15:00	Kees-Jan Leliveld, ALSI **On the application of vision technology for semiconductor laser dicing**
15:00-16:00	Break
16:00-16:30	Hans Rovers, TU Eindhoven **Multiphysical modelling of high-precision planar motors**
16:30-17:00	Dick van Hees, ASML **Mitigate the assembly risks during design based on a risk prediction model**

Subject to change.

AGRO & FOOD

9:30-10:00	Ivo Ploegsma, Foodworkx **High tech opportunities in a globalizing food industry**
10:00-10:30	Martijn Wisse, TU Delft **Robots that work**
10:30-11:30	Break
11:30-12:00	Bart Missotten, CNH **Increasing food production with 70 percent by 2050**
12:00-12:30	Shay Navon, Kverneland **GPS-based control for synchronised seed placement by precision drill**
12:30-14:00	Lunch
14:00-14:30	Rien den Boer, Aris **Design and realisation of a high-speed chicken grading system**
14:30-15:00	Leon Bemelmans, Beltech **3D vision technologies and application examples in agro and logistics**
15:00-16:00	Break
16:00-16:30	David Epema, Lely **Automated milking of cows**
16:30-17:00	Wilbert Hilkens, ABN Amro **Agro and hightech can tackle small gross margins and world food quest together**

CO-DEVELOPMENT

WEDNESDAY 24 APRIL, 9:30-10.30 H

- **Jos Benschop**
  Senior Vice President Technology, ASML
- **Wolfgang Rupp**
  Senior Vice President R&D, Carl Zeiss SMT

ASML-Zeiss, a successful partnership enabling Moore's law

Moore's Law dictates that every 18 months the number of transistors on an integrated chip doubles. This is first and foremost enabled by optical lithography printing ever smaller transistors on an integrated circuit. Since 1984 ASML has steadily grown its market position, in a growing market, through superior value-of-ownership which is enabled by technology. Carl Zeiss has been key in this success, supplying various generations of optics. After a short introduction on ICs and optical lithography, past present and future of optical lithography will be shared. It will be explained how the ASML-Zeiss partnership has evolved over time, and immersion and EUV case studies will be shared.

WEDNESDAY 24 APRIL, 11:30-12:30 H

- **Guido de Boer**
  COO, Mapper Lithography
- **Serge Tedesco**
  Business development manager for advanced lithography, Leti

Development infrastructure of the Mapper lithography tool

Mapper supplies an alternative lithography solution. The solution being developed offers a ten wafer per hour system for 32 nm half pitch writing on 300 mm wafers for an equal or better price than the competition. In the first talk, Guido de Boer will explain how the development of the machine has been organized in terms of technology and project management. Some less traditional choices in organization and system architecture have been made. This has been done in order to enable the development of this complex machine with relatively little people. Also from the suppliers a high degree of taking responsibility is required. In the talk this role will be explained and an outlook will be given on Mapper's next phase of small series production.
In the second talk, Serge Tedesco will outline what is required to make a new lithography technology successful and what is important for customers. Such a new technology requires changes to the environment of the tool. New resists have to be qualified, the data preparation infrastructure and algorithms have to be verified and the total performance of tool and environment together has to be validated. Tool assessment has to be achieved following end user's requirements and infrastructure has to be ready in time through co-suppliers collaborations (resist vendors, data preparation solution vendors). Leti has set up a consortium around the program called Imagine to verify Mapper's multiple e-beam direct write solution and to create the infrastructure around it.

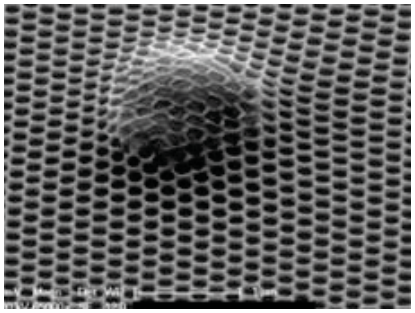
WEDNESDAY 24 APRIL, 14:00-15:00 H

- **Marc Verschuuren**
  Senior scientist, Philips Research
- **Ulrike Schoembs**
  Product manager Aligner, Süss Microtec

From research to production – Transfer of in-house developed nano-imprint technology from Philips Research to Süss Microtec

Philips is interested in using micro- and nano-structures to enhance the performance of their products. Examples are brighter LEDs for solid-state lighting, more efficient lasers for optical tracking and decorative holographic patterns to hinder counterfeiting of Philips products.
Soft lithography is a name for technologies that use rubber stamps to transfer information, analogue to the chrome shadow mask in optical lithography. It is a promising technology to apply nano-structures on large areas in a cost-effective manner. Pioneered by Harvard University in 1995, Philips Research developed tooling for micro-contact printing

and nano-imprint lithography; the latter became known as substrate conformal imprint lithography (Scil). Scil combines nm resolution and low pattern deformation of rigid stamps which are expensive, fragile and small area, with the low cost, flexibility and durability of rubber stamps. In 2006 Philips transferred Scil from research to its service organization Miplaza/PINS to make it available for customers in and outside Philips. In order to commercialize the technology Philips approached Süss Microtec, a leader in semiconductor equipment, for licensing. It appeared that Scil tooling was compatible with integration in their existing mask aligner portfolio. So in 2007 the Scil technology was transferred to Süss Microtec in a technology license agreement.
At this point Süss Microtec already had different imprint solutions in their portfolio but the interest in the Scil technology was based on a good cost of ownership of the process, the suitability for key markets like LED and an extension of the existing options by a very promising imprint technology. For best flexibility Scil got integrated as an option in Süss' manual mask aligner platform MA/BA6 and later also in MA/BA8 Gen3 so that imprint up to an area of 200 mm can be commercially offered now.
The presentation will introduce the Scil technology and show how it is used in applications.



WEDNESDAY 24 APRIL, 16:00-17:00 H

- **Ronald van Dijk**
  Manager engineering, SoLayTec
- **Robert Hendriksen**
  Software architect, Sioux

How modular system architecture and software simulators enable short time to market

SoLayTec is an original equipment manufacturer for the solar industry. It develops machinery for atomic layer deposition (ALD), enabling solar cell manufacturers to achieve higher cell efficiencies. Having already successfully developed a low-capacity (100 wafer per hour) lab tool, SoLayTec was challenged to develop a high-volume (up to 4500 wph) production tool in a very short period of time.
When designing and constructing such a complex, first-of-a-kind system from scratch, you are confronted with many changes and uncertainties during a large part of the development process. Modularity, the extensive use of test rigs and software simulators are ways of managing multidisciplinary dependencies and mitigate risks and uncertainties.
The very short time to market demand led to an extreme concurrent project approach, forcing the design team to uphold module interfaces, function cohesion and limit interdependencies. This high modularity enables us to easily define system configurations, therefore meeting the current and future customer demands. An additional benefit is the ease of defining field replaceable units to further mitigate risks after field introduction. The philosophy of 'graceful degradation' and 'graceful upscaling' were important drivers in the design process.
The expertise of Sioux on domain specific languages and the software development process in general was applied to support SoLayTec's modular engineering approach in an agile way. Simulators have proven their value during the system conception phase and all subsequent development phases and have alleviated the work-related dependencies, thus reducing overall project risk.

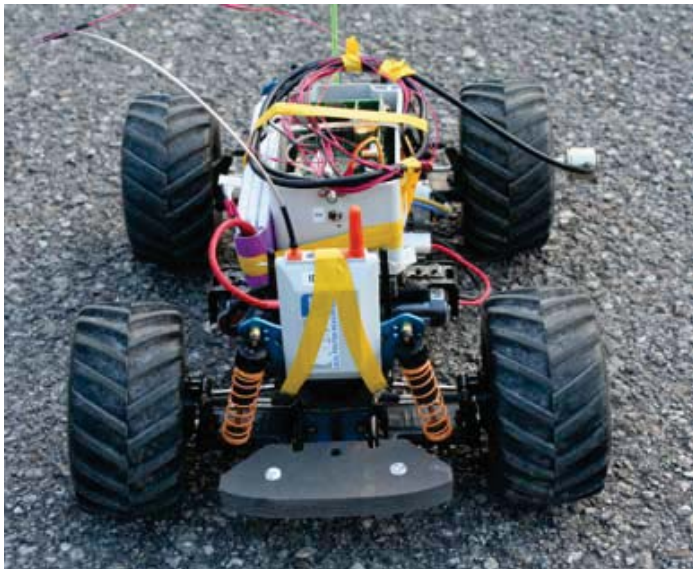
AUTOMOTIVE

WEDNESDAY 24 APRIL, 11:30-12:00 H

• Reimar Pfeil
Senior researcher, Austrian Center of Competence in Mechatronics

RF-based local positioning for autonomous driving

Many technical areas require an automated vehicle to drive from one point to another, e.g., mines, factories, hospitals, etc. Based on almost a decade of experience gained with the local positioning measurement (LPM) system from Inmotiotec, Linz Center of Mechatronics proposes the application of LPM for these tasks.
Generally, LPM was developed for surveillance purposes in high dynamic sport (e.g. soccer, speed skating), but it can also be used to track unmanned aerial or ground vehicles (UAVs/UGVs) with an accuracy of some centimeters outdoor and less than 50 cm indoor. Moreover, LPM can be used to track race cars and to monitor their dynamics (e.g. if the the car starts to drift). A major benefit of LPM is the scalability from some meters up to more than 1,000 m without loss of precision.
In this presentation Reimar Pfeil will give a short review of the LPM system and demonstrate its application for the tracking of UGVs and that it can also be used for autonomous driven vehicles. Moreover, he will show various other areas where LPM is currently used.



WEDNESDAY 24 APRIL, 12:00-12:30 H

• Menno Beenakkers
Control engineer, DAF Trucks

Advanced drive-off control strategy for trucks

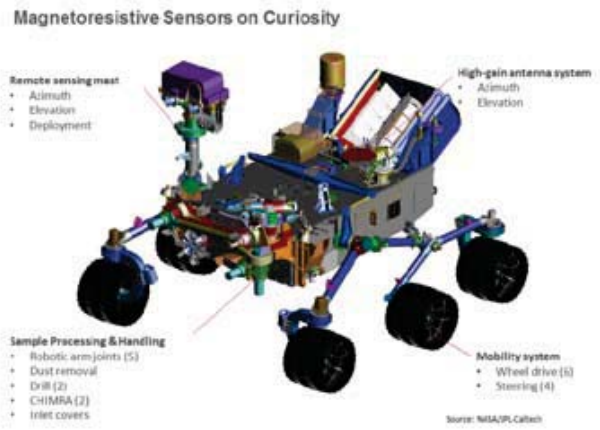
One of the key driveline elements is the gearbox. For driving-off and manoeuvring the clutch actuation is most important for good drivability and comfort. Due to (material) legislation, diminished clutch facing damping can lead to clutch oscillation (clutch judder), which leads to driver's discomfort in the cabin. DAF Trucks has developed a controller to actively suppress clutch judder and so being able to further optimize the drive-off events. The advanced drive-off control strategy has changed the total vehicle response during drive-off, i.e. from pressing the accelerator pedal, via the control of the clutch and engine, up to the longitudinal and vertical motion of the vehicle. Functional integration of the different systems (engine & gearbox ECU), tuning and guaranteeing robustness were the main challenges during the development process.

WEDNESDAY 24 APRIL, 14:00-14:30 H

• Rolf Slatter
CEO, Sensitec

Getting magnetoresistive sensors to Mars and further

The usage of magnetic sensors is increasing steadily in the field of electric drives. Above all magnetoresistive (MR) sensors are experiencing a significant increase in applications in motion control systems, in industrial, medical, automotive and aerospace fields.
One of the most demanding application areas is in space. The combination of wide temperature range, high mechanical loading and exposure to radiation makes this a particularly difficult environment for sensors. The robustness of MR sensors is shown by Curiosity, the planetary rover that landed on Mars in August 2012. 40 MR sensors



are used to control the electric motors driving almost all the moving mechanisms on Curiosity. These sensors joined the 78 MR sensors already on Mars since 2004 as part of the Spirit and the Opportunity. The presentation will cover the development of the commercial off-the-shelf MR sensors used for Curiosity. It will also describe the basic physical principles and will outline the numerous different measurement tasks that are possible and will compare the MR effect with other physical principles that are used for sensors in electric drives. MR sensors can be used for the measurement of rotational and linear motion, proximity measurement and for current measurement.

WEDNESDAY 24 APRIL, 14:30-15:00 H

- **Siegfried Silber**

  Business unit manager, Linz Center of Mechatronics

More efficient high-performance permanent magnet machines in automotive

Electric motors are increasingly used in automotive applications, covering a variety of functions ranging from small actuators to traction motors. In many cases, these motors replace hydraulic systems or systems that are driven directly by the engine, to reduce the carbon emission of cars. The most important design requirements are high power density, low weight, and cost-effectiveness. Rare-earth magnets are often the magnetic material of choice for achieving compactness, but supplies of the raw materials from which these are made, like those of copper, are limited. Thus, there is an imperative to minimize the resources required to realize a high-performance motor.
A software tool that makes multi-objective optimization of electric motors possible will be introduced by Siegfried Silber of the Linz Center of Mechatronics. With this tool the trade-off between efficiency and material or manufacturing costs can be analysed. Examples of optimized motors for automotive applications using rare-earth magnets will be presented. Additionally, alternative motor topologies such as synchronous reluctance machines and machines with buried ferrite magnets are compared.

WEDNESDAY 24 APRIL, 16:00-16:30 H

- **Sander Kemna**

  CEO, Inmotion

Finishing the 24H of Le Mans with an electric car

What started out as a student project at Eindhoven University of Technology evolved into a new business start-up. Inmotion is an technostarter that develops innovative ideas in mobility and commercialises them, taking the ideas to the market through spin-offs and licenses. These ideas are created when young engineers work on the challenging project, the IM01, which aims to finish the 24H of Le Mans using green technology. Sander Kemna is investigating different hybrid drivetrain topologies to find the optimum solution for the topology of the series hybrid IM01. The IM01 will drive a full day continuously with speeds in excess of 350 km/h. One can imagine that this has never been done before by an electric car. A battery pack, ultracapacitors, electric motors and a very efficient generator are the main components which will propel this car to such speeds.

WEDNESDAY 24 APRIL, 16:30-17:00 H

- **Bert Dexters**

  Project manager functional safety, Flanders' Drive

Functional safety engineering methodology for automotive and off-highway vehicle

A sound engineering methodology is not only a must for safety-critical applications. It is often also more economical to resolve issues at the design stage and not later on when the product has been developed or is already in production. Often, a formalized approach can also result in a more cost-efficient design. Complexity is not only the enemy of safety but also of cost efficiency. With a sound methodology, everybody wins. Flanders' Drive developed a functional safety engineering methodology based on the leading vehicle and machinery functional safety standards, together with six partners in the Flemish industry and with support of Tüv Nord Mobilität. This presentation demonstrates the functional safety engineering methodology and the learnings achieved via practical use-cases within automotive and off-highway: an electric powertrain application by Flanders' Drive and a driveline system application by Grammer EIA Electronics and Dana Spicer Off-Highway.

MEDICAL SYSTEMS

WEDNESDAY 24 APRIL, 9:30-10:00 H

• **Heike Vallery**
Assistant Professor, TU Delft

Robots to help humans walk and balance

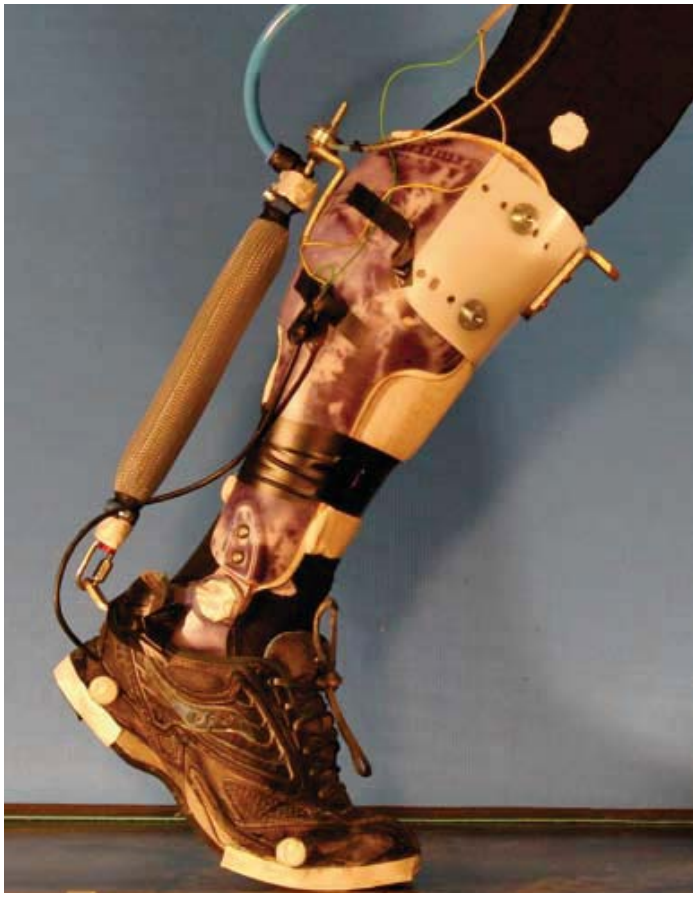
Robotic technology to replace or assist human legs has made major advances in recent years. However, clinical experience still reveals limitations in terms of functionality and therapeutic outcome. One reason is that current designs often limit user autonomy, due to kinematic constraints and undesired interaction forces between the user and the robotic device. This talk will present hardware and control concepts for user-centred assistance of bipedal gait, ranging from minimalistic kinematics over the targeted use of compliance to collaborative balance control. Embodiments and experimental results will be shown for all concepts, for example a robot for overground gait training in rats, which enabled ground breaking research on recovery after spinal cord injury, and a recent extension of the robotic principle to human scale.

WEDNESDAY 24 APRIL, 10:00-10:30 H

• **Philippe Malcolm**
Post-doctoral assistant, Ghent University

A simple pneumatically powered exoskeleton can reduce the metabolic cost of walking

Even though walking can be sustained for great distances, considerable energy is required mainly by the ankle muscles. Different companies and university labs are building powered exoskeletons for improving walking performance in able-bodied subjects (e.g. rescue workers) or impaired subjects (e.g. elderly).
None could achieve a metabolic reduction beyond the level of walking without exoskeleton, possibly because there is no consensus on the optimal actuation timing to assist the push-off during walking. The main research question of our study was whether it is possible to obtain a higher reduction in metabolic cost by tuning the actuation timing.
Test subjects walked with an exoskeleton that assists ankle extension by means of pneumatic artificial muscles that contract with different actuation timings in different conditions, from an early actuation timing (starting before push-off) to a late actuation timing (starting during push-off). We measured metabolic cost by means of respiratory gas analysis. We found that the exoskeleton can reduce metabolic cost by approximately 6 percent below the cost of walking without exoskeleton if actuation starts just before opposite leg heel contact.
While the present exoskeleton was not ambulant, measurements of joint kinetics reveal that the required power could be recycled from knee extension deceleration work that occurs naturally during walking. This demonstrates that it is theoretically possible to build future ambulant exoskeletons that reduce metabolic cost, without power supply restrictions.



WEDNESDAY 24 APRIL, 11:30-12:00 H

• **Eric Smeets**
Mechatronic systems engineer, Philips Healthcare

Motion challenges in a medical environment

In image guided intervention therapy (IGIT) X-ray equipment, machine functionality and image quality are of prime importance, immediately followed by safety (patient and personnel) and machine reliability. Functional requirements for these machines are more or less the same all over the world but the same X-ray equipment is used in a wide field of diagnostic and intervention procedures and these change continuously. The medical playing field is also different from the production equipment field. This has consequences on the drive architecture of these systems. Being in the medical business imposes special constraints on equipment

specification such as a high level of hygiene, versatility, smooth GUI, medical applications, equipment support and safety. These characteristics lead to architectural demands in areas of openness, insensitivity to third-party physical interfaces, flawless operation, backwards compatibility and modularity.
The control architecture must have an extendible and flexible character while being safe. Testing is extensive and subjected to international and local standards. Evidence is audited. Medical equipment often uses medical grade components which conflicts with the desire to use standard components. The discussion is on how to match the control needs in a medical environment with affordable motion control equipment.

WEDNESDAY 24 APRIL, 12:00-12:30 H

- **Jos Meuleman**
  Systems engineer, Moog Robotics

Lopes II - the design of a rehabilitation robot for walking

Robotic gait training has developed over the last two decades, yet there is much room for improvement in the design of the robots. With the conventional exoskeleton structures, donning of patients in a gait trainer usually is a cumbersome process due to the need of joint alignments. And though the devices are intended to support walking, the challenge is to allow persons to walk freely and make their own mistakes. In existing exoskeletons normal walking is often hindered due to obstructed arm swing and a limited number of degrees of freedom. In the redesign of Lopes, we used a novel design in which these drawbacks are reduced to a great amount. By using a shadow leg behind the patient, little alignment is needed, the area lateral to the hip is left free, and thus arm swing is possible. The construction is lightweight, because the actuators are mounted on a fixed base and the transmission of power is executed with lightweight rods. Additionally free motion is possible in numerous degrees of freedom. The device has been built, now tests with subjects are required to assess if subjects can indeed walk normally in the robot.

WEDNESDAY 24 APRIL, 14:00-14:30 H

- **Hernes Jacobs**
  Mechatronic systems engineer, Demcon

A close look on advanced eye surgery

An eye surgeon uses a variety of tools like cutters, scissors and lasers to operate on the eye. A fluid injection and extraction system to remove particles and keep the eye stable is one of the key features of the surgeon tool. These fluids flow through the eye and a sterile disposable cartridge on the system. The fluid pump on the system must be stable, fast and safe to give the surgeon absolute control.

There are mainly two types of pumps in the market, a venturi and a peristaltic hose pump. The venturi is fast but has a higher risk of uncontrolled volume extraction. The peristaltic hose pump is safer but is slower and has wrinkles in the flow. D.O.R.C. is a company of leading ophthalmic surgery tools and systems. They found in Demcon their ideal partner for the development of their next generation system. Demcon started from scratch and came up with Eva, a total posterior and anterior surgical system. The pump system in Eva is such that it has the advantages of both the venturi and peristaltic pump without the drawbacks. This results in more accurate and safer eye surgery.
The cooperation between D.O.R.C., Demcon, D'Andrea & Evers Design and Medistad has resulted in an eye catcher which will be presented in this presentation.

WEDNESDAY 24 APRIL, 14:30-15:00 H

- **Bastian Deutschmann**
  Researcher, Deutsches Zentrum für Luft- und Raumfahrt (DLR)

DLR Mirosurge – A robotic system for research in telesurgery

The system Mirosurge, currently a research prototype, can be counted among the class of systems for minimally-invasive robotic surgery (MIRS). In MIRS, slender instruments are introduced into the patient's body through small incisions. Robotics is applied to increase the surgeon's effective dexterity and immersion as well as to enable new instrument design.

The DLR Mirosurge includes an input (master) console as well as a teleoperator consisting of three surgical robots (Miro). Each robot has seven degrees of freedom and exhibits joint sided position and torque sensors. Usually two Miro's carry surgical instruments (Mica) with three additional degrees of freedom as well as miniaturized force/torque sensors to capture reaction forces with manipulated tissue. One more Miro can (automatically) guide a stereo video laparoscope. Both the stereo video stream and the measured forces are displayed to the surgeon at the master console. Since Mirosurge is a highly integrated mechatronic system, the presentation will focus on the mechatronic design of Miro and Mica. Furthermore, it covers the main ideas concerning the communication architecture and the control modes realized within the system.

WEDNESDAY 24 APRIL, 16:00-16:30 H

• **Erik van Oene**
Master student, TU Eindhoven (on behalf of Focal Meditech)

Motion-controlled arm support

Last year Focal Meditech introduced a new electronically controlled passive dynamic arm support to the market, called Darwing. The Dutch manufacturer and supplier of high-end assistive technology is already working on a new concept for highly challenged people with for instance muscular disorders. Within this project, the main goal is to develop a motion-controlled arm support (McArm). The basic concept of the McArm device is the use of haptic technology for the realisation of an active dynamic arm support with an even higher level of performance. One of the many important parts of the McArm device is the implementation of an admittance controller. In this presentation the performance of the joint space and task space implementation of the admittance controller will be discussed.

WEDNESDAY 24 APRIL, 16:30-17:00 H

• **Loretta van Kollenburg**
Managing Director, Hybriscan Technologies

Unique analytical high-tech platform in correlative imaging

A scanning electron microscope (SEM) combined with Raman micro-spectroscopy provides a powerful instrument for micron- and nano-scale visualization of samples and provides a unique analytical high-tech platform for a broad range of life sciences materials questions. Hybriscan Technologies integrated Raman micro-spectroscopy with electron microscopy and developed and produced these microscopes together with De Koningh Advanced Technology.

During the development process the main challenge was in building a high-end Raman microscope and a compact and light optical microscope that can be integrated. The design within high constraints and very small spaces was essential. The consolidation of the optical path and the stability of the optical components and high precision (< 1 micron) of moving parts were required. Knowledge of optical and electron microscopy and working in vacuum under safety conditions was a must to obtain the desired product. Developing and producing the Raman module and the pick-up Raman detector objective at very high tolerances places our end-product on the high-end market roadmap in correlative imaging.

SEMICONDUCTOR TECHNOLOGY

THURSDAY 25 APRIL, 09:30-10:00 H

- **Dirk Tjepkema**
  Mechatronic systems engineer, Demcon

Active hard mounts: the future vibration isolation for lithography machines?

Floor vibrations and disturbance forces cause vibrations of the metro-frame and projection lens inside a lithography machine and therefore lower the machine's performance. To reduce the effects of these vibrations, the metro-frame is usually constructed as a heavy-weight body suspended by low-stiffness air mounts. Although the use of such soft mounts results in a low transmissibility of floor vibrations, the metro-frame becomes sensitive for disturbance forces (e.g. due to cables or acoustics). Furthermore, the vertical position of the metro-frame must be actively controlled to compensate for gravitational sagging. Both problems can be circumvented by using active hard mounts. These provide for a much stiffer suspension, while active control is used to improve the response to floor vibrations.

At the University of Twente, vibration isolation using active hard mounts has been studied in a PhD research project. This project has been supported by SmartPie, a scientific research program on piezo technology.

For the active control, a control strategy based on measurements from piezoelectric accelerometers placed on the metro-frame as well as piezoelectric force sensors placed in the mounts is used. With this approach 'virtual mass' is added to the metro-frame, which has a similar effect as lowering the suspension stiffness. This allows to construct the metro-frame in the future as a light-weight body. At the same time much damping can be added to resonance modes of the projection lens which are otherwise poorly damped.

The control strategy has been successfully implemented on a proof-of-principle set-up that represents a six-axes active hard mount vibration isolation system suspending a frame having internal dynamics. The results demonstrate that state-of-the-art transmissibility transfer function curves can be combined with a more than hundred times stiffer suspension and damping ratios of more than 20 percent for the resonance modes of the frame.

THURSDAY 25 APRIL, 10:00-10:30 H

- **Bas van Nooten**
  Director European cooperative programs, ASM International

450 mm: Opportunities for the European E&M industry?

The wafer size transition from 200 to 300 mm proved to be an opportunity to newcomers on the semiconductor equipment market, or to obtain new customers. This wafer transition was accompanied with important changes in the semiconductor industry, especially on manufacturing topics with new strategies (e.g. front opening unified pod or Foup), fab automation, enhanced focus on yield and many new Semi standards.

In the current transition from 300 to 450 mm such radical changes are not foreseen at the moment. Initial new ideas, like moving away from so-called Foup integrity to simplify fab automation and number of Foups in the fab were already discarded. The goal seems to be to implement as less changes as possible (e.g. 450 mm Foup) and leave fab automation software as is.

Now does this general 450 mm roadmap offer the same opportunities for the equipment and materials industry as in the previous transition, especially for newcomers or smaller players, as present in Europe?

In 2009 the European electronics and manufacturing industry enthusiastically joined in the EEMI450 initiative to cooperate on pre-competitive 450 mm R&D topics. Out of this enthusiasm several projects arose, which were funded by the different European cooperative research mechanisms. Starting with an initial ground layer to support possible follow-up projects was the EEMI450 project, which ended in 2012. Several more detailed and larger projects followed, like NGC450, SOI450, EEM450PR and lately E450EDL. Most participants in these project were already involved in the EEMI450 community, but others joined as well. In the presentation a short overview will be given of each project, the participants and the targeted results.

Whether all these efforts will result in a 450 mm semiconductor customer base for European E&M companies, still lays ahead of us. It is obvious that G450C plays an important role in introducing 450 mm equipment to the major semiconductor manufacturers, but the close relationship with Imec as being the site for a European 450 mm pilot-line could be an advantage.

THURSDAY 25 APRIL, 11:30-12:15 H

• Doede Kuiper
Director 450 mm development, ASML

450 mm, a new challenge in mechatronics systems development

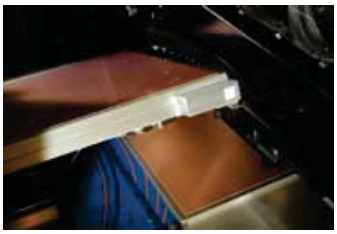
The semiconductor industry is on the edge of a transition to a larger wafer size, from the current 300 mm wafers to 450 mm wafers. The driver for increasing the wafer size is in economics of scale in the wafer fabs, with larger amounts of chips being handled per wafer lot.
For ASML this entails that for both the immersion and the EUV product lines new scanners are needed that can handle this enlarged wafer size. The presentation will reveal the challenges this brings to both the technical and the managerial aspects of this development.

THURSDAY 25 APRIL, 14:00-14:30 H

• Per Carlqvist
Senior specialist, Micronic Mydata

Twin tables in Micronic Mydata's LDI 5S

Micronic Mydata has launched a high-throughput laser direct imaging tool, the LDI 5S, for patterning of organic substrates with sub 10 µm resolution. The tool can produce over 100 panels per hour without using photomasks. A flexible pattern alignment function can adapt the pattern to the actual shape of each panel without reducing throughput. The high productivity is made possible by the twin-table concept which allows panel measurement to be performed on one table in parallel to exposure on the other.
The concept requires the twin tables to switch places rapidly without changing the measured shape of the panel. Table switching introduces relatively large bending forces that require the tables to be stiff to prevent them from deforming in such a way that the panel may slip, making the measurement invalid. Furthermore, the structural properties of the tables should be sufficient to limit the deformation amplitude of the tables due to acceleration forces created by the servo.
A comparison of properties of different table designs will be presented, including modal analysis and deformation during acceleration. One design included a constrained layer damping to achieve high damping and relatively high stiffness. However, the design led to unexpected effects of unpredictable residual deformation of the table in micrometer range after lifting. A mechanism explaining the residual deformation will be discussed and a solution to achieve predictable behaviour of the tables will be presented.



THURSDAY 25 APRIL, 14:30-15:00 H

• Kees-Jan Leliveld
Senior innovation manager, ALSI

On the application of vision technology for semiconductor laser dicing

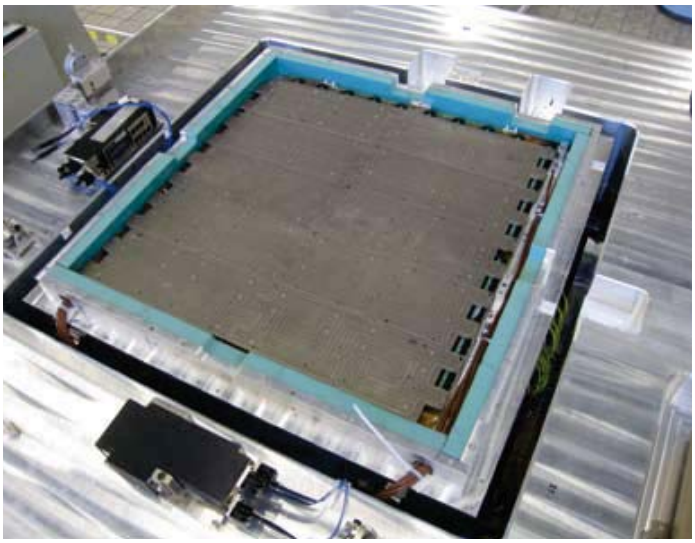
Advanced Laser Separation International (ALSI) in Beuningen, a spin-off from Philips Semiconductors, started in 2001 with the development and production of laser dicing machines. Now, ten years later, the 4th-generation platform, the ICA 1204, is successfully introduced into the market.
In the ICA 1204 platform vision is a key technology for successful laser dicing of semiconductor wafer material. The requirement to fulfil is to position the wafer such that the laser beam is focused exactly in the middle of the dicing street. This is achieved in various steps: 1) wafer contour detection with contour camera images from the pre-alignment station; 2) positioning of the wafer on the laser dicing system to enable accurate alignment; 3) fine alignment of the wafer using the on-axis camera images. The result is that the laser beam is exactly focused on a cross point in the middle of a dicing street. The alignment steps will be presented in detail including the applied vision algorithms. Furthermore some alignment examples will be presented.
In the second part of the lecture a new feature of the platform will be addressed: the usage of on-axis camera images during the dicing process itself. By using these images it is possible to calculate corrections for the wafer movements and thereby achieve a more accurate dicing kerf.

THURSDAY 25 APRIL, 16:00-16:30 H

• **Hans Rovers**,
PhD student, TU Eindhoven

Multiphysical modelling of high-precision planar motors

The semiconductor lithographic industry demands increasingly higher accelerations and accuracies. Present day wafer stages offer positioning accuracies of about one nanometre, and accelerations of several tens of m/s^2. This is achieved by a stack of two motor types, i.e. a planar motor for long-stroke motion, and short-stroke actuators for accuracy. A, for this application, novel planar motor type is investigated, in which the moving part consists of a light – and flexible – plate with permanent magnets, magnetically levitated above a stationary coil set, the stator. The goal is to achieve the desired accuracy and stroke with this planar motor type, without the use of the short-stroke actuators. This would significantly decrease the mass and complexity of the moving part.
The flexible structure of the moving part demands attention to its mechanical behaviour. To this end, the electromagnetic forces and torques acting on the permanent magnets are calculated using an electromagnetic model, on the basis of which a mechanical model calculates the deformation of the plate. The temperature distribution in the coil set is calculated using a thermal model. The coupling of these three models simulates the multiphysical behaviour of the planar motor. Using this multiphysical model, a novel planar motor topology is synthesized, which offers better performance compared to other planar motor topologies. A prototype is under construction.



THURSDAY 25 APRIL, 16:30-17:00 H

• **Dick van Hees**
Technical supplier manager, ASML

Mitigate the assembly risks during design based on a risk prediction model

Mechatronic assemblies are becoming more and more complex; not only in functionality, but also in their assembly. With the market pressure to deliver these increasingly complex assemblies in shorter lead-times – with the right quality – insight is required as early as possible to identify any risks of the assembly not functioning.
In order to determine the contributing factors to these risks, ASML has started a program together with a number of their production partners, design houses, knowledge institutes like Imec and TNO, and also Philips Healthcare, Assembléon and FEI. Based on a model which was implemented by Imec for printed circuit boards (PCBs), a model has been created which gives insight in the assembly risks, in a structured and quantified manner, based on the bill of materials and 3D design. The result is a predicted zero hour defect rate and the list of the major and minor contributors to this ZHDR. These risks can be mitigated by either altering the design or adjusting the manufacturing process accordingly or – when this is not possible – testing this risk area specifically to ensure that the malfunction will not occur at the customer.

AGRO & FOOD

THURSDAY 25 APRIL, 09:30-10:00 H

• **Ivo Ploegsma**
Managing Director, Foodworkx

High tech opportunities in a globalizing food industry

The global food (and related) industry is huge and facing big challenges. Increasing raw material prices and a fast increasing world population require more efficient and process-controlled production systems. Food processing and packaging are becoming increasingly important in order to reduce wastage and to feed the world in a sustainable way.
Innovation and technology improvements are key to manage the challenges of tomorrow. Cross-industry alliances and innovation can help the Netherlands to maintain its dominant export position, both in agro & food products as well as in technology. There are new opportunities for high tech companies and their technology in a stable and fast changing food industry. Demands for automation, new sensor technologies, tracking and tracing software and process control systems offer new markets.
A helicopter view on market, industry and (consumer) product development and drivers as keynote to the more technical insights in the programme and presentations following.

THURSDAY 25 APRIL, 10:00-10:30 H

• **Martijn Wisse**
Associate Professor, Mechanical Engineering, TU Delft, and Chief Technology Officer, Lacquey

Robots that work

Robot automation is gaining ground outside the traditional (automotive) industries. One of the sectors currently poised for large-scale robotic automation is the food & agro industry, a large economic sector in the Netherlands that currently still strongly relies on manual labor.
The food & agro industry has two special flexibility requirements. First, the robot systems must be flexible or adaptive to the fact that each product is different in shape and size. Vision-based robotics and adaptive grasping technology will fill this flexibility need. Second, the customer preferences change often, and the supply varies throughout the year. The usual return on investment of two to three years – as common in most manufacturing applications – is too long for the volatile food & agro market. A number of national and European initiatives address this problem by developing novel, flexible, modular robot solutions.
TU Delft coordinates a large-scale research initiative called 'Robots that work', aiming to develop the next-generation robot technology for flexible, adaptive and modular robot systems. In this presentation, Martijn Wisse will provide an overview of the research agenda consisting of robot grasping, robot vision, intrinsically safe robot manipulators, robot communication and quality monitoring.

THURSDAY 25 APRIL, 11:30-12:00 H

• **Bart Missotten**
Manager R&D crop harvesting systems, Case New Holland

Increasing food production with 70 percent by 2050

Population growth and changes in diet towards more meat consumption require 70 percent more food production by 2050. With that, water and energy consumption will raise dramatically. A huge challenge for engineers in all disciplines to come up with viable solutions and technologies. Improvements in crops varieties with higher yield and less water and nutrient/pesticide input are certainly on the list. However, there will be more needed than just improvements. Cultivation techniques for new crops will have to be developed to be able to plant/seed or harvest them on soils that are more difficult to cultivate. A

plant can be a very good energy source, but being able to harvest and transport it in an efficient way is mandatory.
Another evolution going on for decades is that less and less farmers are available to produce the ever growing demand on food. That is where automation of the agricultural machines and processes comes in. Harvesters and tractors controlled in forward speed and steering with 2,5 cm precision checking the quality of the end product using image processing techniques are already current activities. However, automation and certainly fail-safe off-road autonomous vehicles in a non-controlled environment (outdoor, dust, low sun, rain, fog) are huge challenges.
In the last part a preview is given of the farm of the future with its own energy supply and dedicated technologies and equipment.

THURSDAY 25 APRIL, 12:00-12:30 H

• **Shay Navon**
Manager business development, Kverneland

GPS-based control for synchronized seed placement by precision drill

Kverneland Group's precision seeders for the agriculture industry required a new precision-based seeder control that is capable of putting the seeds in the ground in a synchronized way between the machine working width and between adjacent passes in the field. This seeder, called Geoseed, should allow the farmer to perform crop care actions in parallel and perpendicular direction, and thus requires very accurate single seed positioning.
With the aid of RTK-GPS, new hardware electronics, new software algorithms and intelligent control loops the Geoseed reaches an internal synchronization accuracy on the seed disc < 1 mm. A maximum deviation of ± 4 cm for the pass-to-pass accuracy was achieved in field. The result will be that over its full working width the seeder machine can sow straight line patterns, as well as diamond patterns. Using this technology the farmer can use automatic mechanical weeding, achieve optimal plant growth and increase his profit.
The target for this product design was to realize the high specifications for the synchronized seeding electronics and software algorithms in connection with RTK-GPS satellite data and mapping. No competitor in the world meets this high-end results today.

THURSDAY 25 APRIL, 14:00-14:30 H

• **Rien den Boer**
Senior vision specialist, Aris

Design and realisation of a high-speed chicken-grading system

Each chicken product in a supermarket has been inspected by one or more cameras before it reaches the store. Aris is specialized in vision systems for the agro and food market and has extensive experience in handling natural products. For a new generation of chicken-grading systems from Marel Stork a new architecture of the vision system was required to meet all current requirements and be ready for the future. We show how a multicore pc platform based on Linux can meet these requirements.

THURSDAY 25 APRIL, 14:30-15:00 H

• **Leon Bemelmans**
Director Technology and Development, Beltech

3D vision technologies and application examples in agro and logistics

For quality control vision in 2D has been a powerful technology for already many years. For applications such as autonomous robots operating in semi-conditioned environments, 3D vision offers required solutions. Different methods are available to gather 3D data: stereo vision, structured light and time of flight. These methods will be discussed and examples of applications will be given in the field of agricultural harvesting and logistics.

THURSDAY 25 APRIL, 16:00-16:30 H

• David Epema
Product engineer, Lely

Automated milking of cows

At the end of the 20th century, the most revolutionary invention of the century was introduced into the dairy business: the Lely Astronaut robotic milking system. An astounding and cutting edge concept for milking equipment. The milking robot is the most consistent and reliable milker one can possibly think of; 24 hours a day, 365 days a year, for many years in a row.

One of our engineering challenges is to build a robust milking robot to be used within hard and constantly changing environments, including evolving and sometimes even moody cows. Imagine milking a young, curious and continuously moving cow visiting the robot whilst having an older lady with only three teats walking in ten minutes later. We show how cow identification systems, model-based controlled actuators and finally vision and positioning systems are working together to provide a reliable and robust robotic milking arm.

THURSDAY 25 APRIL, 16:30-17:00 H

• Wilbert Hilkens
Sector manager animal production, ABN Amro

Agro and hightech can tackle small gross margins and world food quest together

The Dutch agritech industry is top of the bill in production efficiency, as the national productivity is five times higher than the European average. Although this starting point is excellent, focus sectors Agri & Food and Horticulture & Genomics still can improve their performance when they look closer to another focus sector: High Tech Systems & Materials. The recent ABN Amro report 'Made in Holland in the square' mentions 'the perfect match' in the combination of all three focus sectors.

The enlargement of the agro market is driven by the growth of the world population, the change towards higher caloric and more luxurious meals and the higher need for bio-energy. Collaboration between focus sectors Agro & Food, Horticulture & Genomics and High Tech Systems & Materials accelerates innovation in the agritech industry and improves its competitiveness worldwide. Furthermore, this contributes to the increasing food supply.

Besides this, the agritech industry helps the high-tech suppliers to reduce their dependence on volatile markets, with diversification of the client portfolio towards more stable and growing markets. For all focus sectors the collaboration stimulates innovation and productivity improvement. One recent example in poultry production shows that with smart vision technology the well-being of chickens can be improved. With close monitoring the nutritional needs of the chickens can be fulfilled more carefully, resulting in improvement of health and thus well-being.

Thursday 25 April, 09:30-12:30 h

SMARTPIE

9:30-10:00	Dirk Tjepkema, Demcon **Active hard mounts: the future vibration isolation for lithography machines?**
10:00-10:15	Theo de Vries, UT/Imotec **Active damping of vibrations in precision equipment**
10:15-10:30	Jan Holterman, Imotec **Energy harvesting with piezo**
10:30-11:00	Wolfram Wersing, Siemens **Technical innovations enabled through piezoelectric innovations**
11:00-11:30	Break
11:30-12:00	René de Vries, Aito **Integrated haptics in touch user interfaces based on piezo**
12:00-12:30	Juha Backman, Nokia **Advantages of piezo in consumer electronics**

Thursday 25 April, 13:30-17:30 h

SENSING MATTERS

13:30-13:35	Kees Donker **Plenary welcome**
13:35-13:50	Jan Maas, INCAS³ **Plenary introduction to HTS&M Sensor Systems roadmap**
13:50-14:00	Break-up

Parallel sessions	Sensor principles	Sensor devices	Sensor applications
14:00-14:25	Ernst Sudhölter, TUD **Bionanosensors**	Youri Ponomarev, NXP **CMOS14 sensor platform**	Maurice Taks, Sensor Universe **Sensor applications by SME**
14:25-14:50	Arjen Boersma, TNO **Chemical sensing using photonic crystals and optical fibers**	Dario LoCascio, TNO **Application of Specific Photonic Integrated Circuits and the Sensing Industry**	Martin Ravensbergen, ASML **Sensors in ASML lithography equipment**
14:50-15:15	Urs Staufer, UT/TUD **Mechanical Sensing - A solution for the ultimate sensitivity?**	Sywert Brongersma, Holst Centre/TNO **Nanowire based sensors**	Peter Laloli, TNO **Adaptive Multi Sensor Networks**
15:15-15:40	Giampiero Gerini, TU/e **Electromagnetic sensing**	Jan Stegenga, INCAS³ **Robust sensors: implications for local processing and hardware**	Remko Uijlenhoet, WUR **Sensors for weather & climate**
15:40-16:05	Dirk Jan Krijnders, INCAS³ **Sound sensing**	Pim Groen, Holst Centre **Piezo sensors**	Jaap-Henk Hoepman, RU/IIPVV **Sensors for security & safety**

16:05-16:35	Break
16:35-17:25	Kees Donker - Panel discussion with Machteld de Kroon, Carel van der Poel, Maurice Tax and Jan Maas **Serious sensing**
17:25-17:30	Kees Donker **Closure**

Holland High Tech

TNO innovation for life

Subject to change.

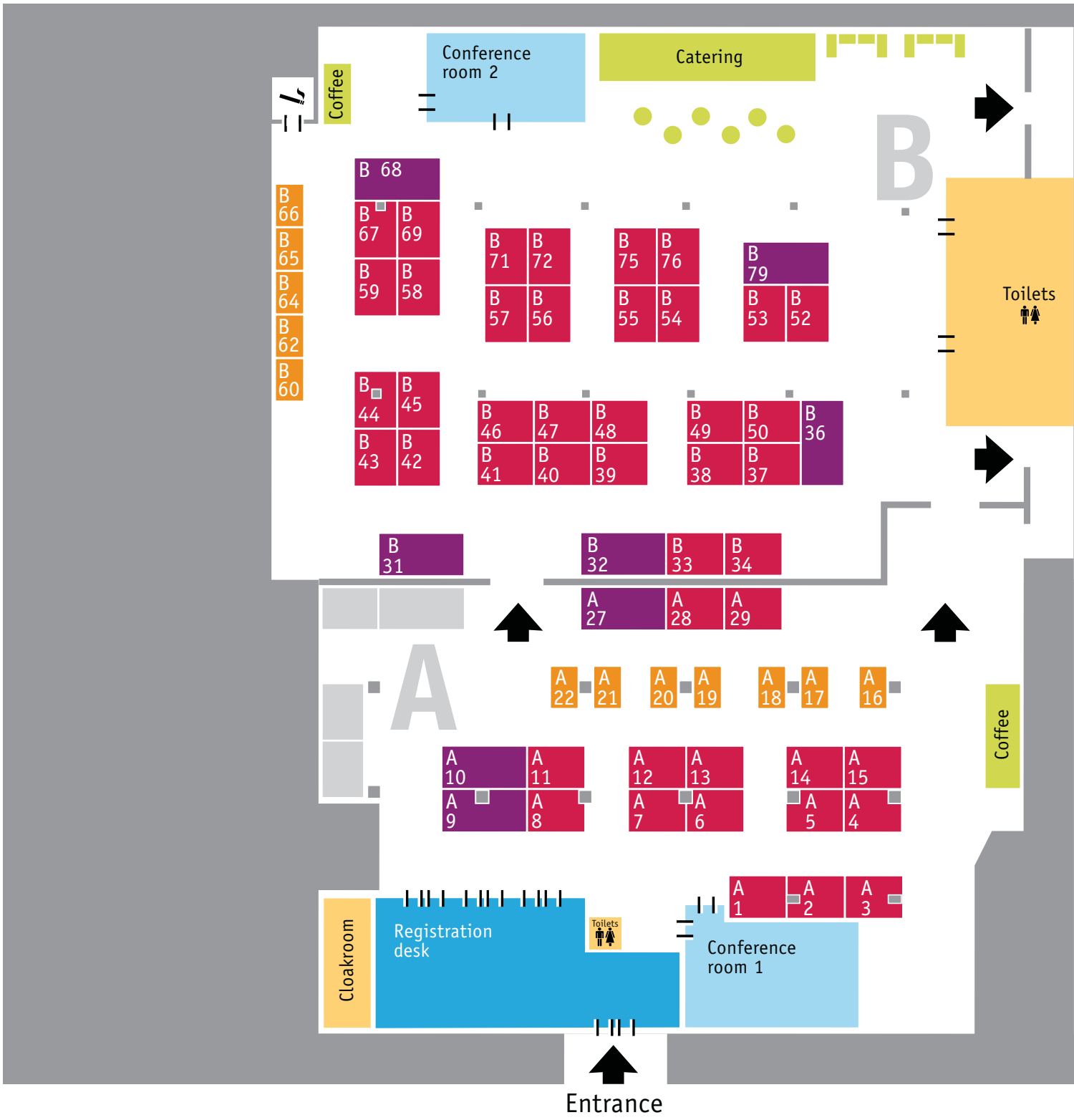
Thursday 25 April, 14:30-18:00 h

SEMINAR "B2B SERVICE BUSINESS"

14:30-15:00	Reception
15:00-15:10	Lex Besselink, Dutch Institute World Class Maintenance **Introduction: Why service business?**
15.10-15:30	Michel Weeda, BOM **Service business opportunities for southern Dutch industry**
15.30-15:40	Amandus Lundqvist, Topsector High Tech Systems & Materials **Handover of the first southern Dutch "B2B Service Business Survey"**
15:40-16:10	Frank Mulders, Fokker Landing Gear **Kenynote lecture: Service business in high tech aviation industry**
16:10-16:30	Lex Besselink (interviews with Michel Weeda and entrepreneurs from "Service as a Business" cluster) **The southern Dutch "Service Business Acceleration" programme**
16:30-18:00	Informal presentations: Service Business Acceleration programme; Service as a Business Cluster; Service Logistics; Field Service Planning; Remanufacturing; Document Services Valley; World Class Maintenance projects **Service business marketplace (in combination with networking drinks)**

Impuls · Brabant Development Agency BOM · DINALOG Dutch Institute for Advanced Logistics · LIOF · Dutch Institute World Class Maintenance · Syntens Innovatie Centrum

Subject to change.



C 108	B 60	A 7	C 128	C 104	C 125	A 8	B 76	C 82	B 41
ASML	3KL	ceratec	DEMCON	DSPE YOUR PRECISION PORTAL	JPE	LEMO	maxon motor driven by precision	NJORA	nts GROUP

B 52	C 89	B 56	C 106	C 83	C 90 95	A 13	B 31	B 68	C 105
Frencken	HEIDENHAIN	hitech group	iai industrial systems	IBS Precision Engineering	PHILIPS	Techwatch bv	TEGEMA	TNO innovation for life	LiS

Stand locations of exhibitors at High-Tech Systems 2013
(hall A, B and C in the Klokgebouw)

3TU	C110
AAE	B45
Aito	C125-C126
AIS Automation	A2-A3
Alten Mechatronics	C92
Altran	B79
arteos	A27-A29
ASML	C108
Bakker Fijnmetaal	C85-C86
Beckhoff.nl/IAL	B53
Befort Wetzlar	A27-A29
BKL Engineering	B60
Brainport Industries	C103
Career doctors	C111
CCM Centre for Concepts in Mechatronics	A18
Ceratec Technical Ceramics	A7
Controllab Products	B38
DEMCON advanced mechatronics	C128
Dutch Precision Technology (DPT)	B40
Dutch Society for Precision Engineering (DSPE)	C104
DVC machinevision	B65
Eltromat	C101
Enterprise Europe Network / Syntens	C98
Festo	B42
Framo Morat	A12
Frencken Europe	B52
GDO	B43
Greentech Engineering	B55
Hauzer Techno Coating	C109
HEIDENHAIN	C89
Hessen Trade & Invest	A27-A29
The High Tech Institute	C131
High Tech Mechatronics	B48
Hittech Group	B56
Holland High Tech	A1
IAI industrial systems	C106
IBS Precision Engineering	C83
Imotec	C125-C126
invenio	A27-A29
Irmato	B37
Janssen Precision Engineering	C125-C126
KMWE	B72
Lamers High Tech Systems	B71
LEMO Connectors Benelux	A8
LiS – Leidse instrumentmakers School	C105
Masévon Technology	B46
maxon motor benelux	B76
micro-part	A27-A29
MI-Partners	C96
MTA	B49
MTSA Technopower	B66
Multivalent Plating & Etching	A20
NanoNextNL	
National Instruments	B57
NextOEM	B62
Nijdra Group	C82
Nobleo Technology	B54
Norma Groep	C87
NTS-Group	B41
Océ-Technologies	C107
OMC	C88
De Ontdekfabriek	
Philips Innovation Services	C90 95
PM-Bearings	A22
Prodrive	C127
ProduktionNRW	B33
RoodMicrotec	A2-A3
SEGULA Technologies	C102
Sensitec	A27-A29
Sensor Universe	A5
Settels Savenije van Amelsvoort	C85-C86
Silicon Saxony	A2-A3
Sorama	A19
Technology Foundation STW	A17
Techwatch	A13
Tecnotion	C93
TEGEMA	B31
Telerex	C101
TEVEL	B58
TMC Group	B36
TNO	B68
Topic Embedded Systems	B32
TRIAS	A16
Universiteit Twente	C125-C126
Variass	A6
VDL Enabling Technologies Group	A11
Vernooy Vacuüm Engineering	B46
Weiss Klimatechnik	A2-A3
Wirtschaftsförderung Sachsen (Saxony Economic Development Corporation)	A2-A3
Xeryon	C85-C86
Yacht Technology	B39
YASKAWA Benelux	B75
Yokogawa	A21

Model-Driven Development Days 2013 (hall D)

Claytex Services	D7
Infinite Simulation Systems	D5
Keonys	D3
MathWorks	D10
MetaCase	D2
MonkeyProof Solutions	D4
Reden	D9
Verum Software Technologies	D1

AAE

The Art of Mechatronics

Knowledge, skills and innovation; these are the three pillars of AAE. Knowledge from synergy and cross-fertilization of four business units: High Precision Parts, Proto and Serial systems, Special Machines and – under the brand name Grauel – Printing and Assembly Automation. Skills through pure craftsmanship, an expert eye for state-of-the-art machine construction and plenty of space and passion for smart technical talent. Innovation by being stimulated and challenged by entrepreneurial customers, one of the most high-tech regions in the world and by putting time and energy into collaboration. AAE is ISO 9001 certified and has an ISO-7 cleanroom. Knowledge, skills and innovation, all at one location: welcome to AAE!

Everything at one location

AAE is an international player in the field of mechatronics. Since its foundation in 1976, our organisation has been based in Helmond. With four independent business units and currently more than 160 employees, we supply, at one location, manufacturers in the medical, pharmaceutical, automotive, plastics, semiconductor, solar and food industries.

Combining without limits

Designing and realising mechanical solutions obviously revolves around knowledge and pure craftsmanship, within a transparent and well-structured organisation. By combining this with passionate people we find solutions that always seamlessly meet your demands, requirements and preferences. Co-development means to think, dare and act together. That is our strength.

- High Precision Parts
- Proto and Serial Systems
- Special Machines
- Printing and Assembly Automation

AAE

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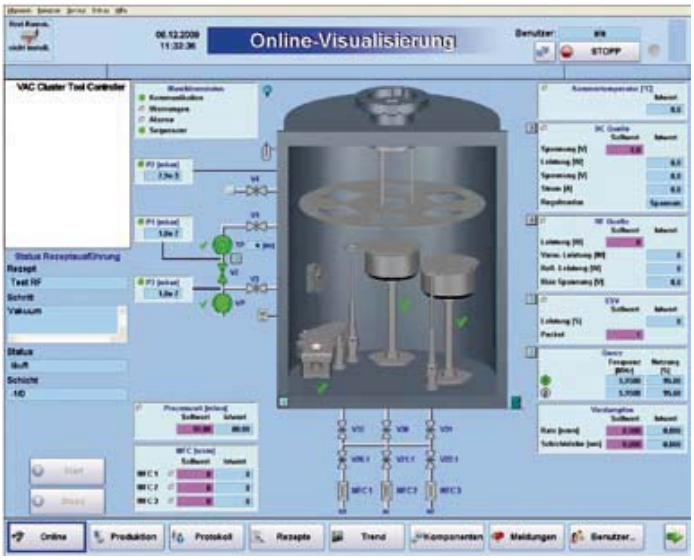
AIS AUTOMATION

AIS Automation provides factory automation and tool control software to customers in the photovoltaic, semiconductor, LED, electronics and automobile industries. Manufacturers and equipment suppliers around the world benefit from our innovative and scalable software that turns customer requirements into solutions. AIS combines 20 years of experience with more than 160 highly skilled employees to deliver proven and value-added software and services for entire factories.



Specializing in the field of tool control software for thin-film applications enables AIS to deliver state-of-the-art solutions for batch, inline and cluster tools. In addition, AIS offers the electrical installation and advanced retrofit/refurbishment solutions for the complete tool.

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AIS AUTOMATION SOFTWARE SYSTEMS

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AITO

Aito is a company with a vision for desirable products with pleasurable interaction. They strongly believe in intuitive user interfaces and complete freedom of design in order to enable consistent user experiences across product ranges.

Aito's mission is to change the perception of touch switches from simple 'input tools' to a rich, intuitive and powerful experience. With that the company aspires to become the world's first choice for premium user interfaces, enabling flexible designs along with easy integration.

Aito's core technology is based on piezo material, a material which has the ability to convert mechanical stress into electrical voltage and vice versa.

AITO BV

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ALTEN MECHATRONICS

Alten Mechatronics is a leading technological consulting and engineering company in which all our activities revolve around technology, especially mechatronics and robotics. We conduct research and development activities and work for leading technology-oriented companies. For these companies we work with highly qualified staff to innovative technical developments. The services of Alten Mechatronics vary from short-term consulting assignments, full-time design and development in your project team to taking over full responsibility of your project.

Within the area of mechatronics, the integral approach to optimally (re)design a mechanical system and its control system, is central. We also specialise in system integration and robotics. We deal with the theoretical implications and practical applications of robots in the broadest sense of the word. Robotics in the Netherlands is still in development and Alten Mechatronics is strongly involved in this technological development.

In the Netherlands we are located in Eindhoven, Capelle a/d IJssel and Apeldoorn. Internationally, we are a part of the Alten Group, which, with 15,950 staff, is active in 15 countries. We are, therefore, one of the leading suppliers of technical consultancy in Europe and have the international presence to take responsibility for the projects we execute. At the same time, our decentralised organisation ensures that we can offer local and customised solutions to specific customer requests.

ALTEN MECHATRONICS

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ALTRAN

Cosponsor

Our Services > Solutions > Intelligent Systems

Intelligent Systems is the name for the new generation of embedded and real-time systems that are highly connected, with massive processing power and performing complex applications.

Intelligent Systems / Altran is Altran's dedicated organisation offering packaged solutions to clients in all industries, helping them create new business opportunities and new experiences for their users in application areas such as autonomous systems, smart phones, smart meters, medical devices, connected cars, advanced air traffic control and smart sensors.

Intelligent Systems / Altran believes that the key challenges for these intelligent systems are not only technology issues such as integration, security and safety but also usage and finding profitable business models. To better answer these challenges, Intelligent Systems / Altran expertise is provided by six global practices, which offer the building blocks for intelligent systems solutions. The six global practices (Systems Engineering, Software Engineering, Electronics, Safety, Security and Connectivity), encompassing 3,000 engineers, are networked into global delivery centres enabling project implementation throughout Asia, Europe and North America. They benefit from registrations such as ISO9001, ISO27001, EN9100 and CMMi ML3.

To know more about Intelligent Systems / Altran, please go to our dedicated web site: intelligent-systems.altran.com.

ALTRAN

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ASML

For engineers who think ahead

ASML is a successful high-tech company headquartered in the Netherlands, which manufactures complex lithography machines that chip manufacturers use to produce integrated circuits. The steady progress of the world's technological evolution through smaller, faster, smarter, more energy-efficient yet more affordable chips is to a large extent the result of technological breakthroughs at ASML. In the space of almost thirty years we have grown from nothing into a multinational with 55 locations in 16 countries and annual sales of 5.6 billion Euros in 2011.

Behind ASML's technological breakthroughs are engineers who think ahead. The people who work at ASML include some of the most creative minds in physics, mathematics, chemistry, mechatronics, optics, mechanical engineering, software engineering, and computer science. And, because ASML spends more than half a billion Euros per year on R&D, our people have the freedom and the resources to push the boundaries of known technology. They work in close-knit, multidisciplinary teams and each day they listen to, learn from and exchange ideas with each other.

The ideal environment for growth

With such a diverse technology culture, generous R&D budget, and a collective determination to create, develop and perfect entirely new technologies ASML represents the ideal environment for professional development and personal growth.

If you have an unbridled passion for technology and want to be part of a team that tries out new ideas each day and constantly searches for better, more accurate, and faster ways of doing things, then visit www.asml.com/careers and send us your application.

ASML

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BAKKER FIJNMETAAL

Development and manufacturing of ultraprecise parts and assemblies

Bakker Fijnmetaal concentrates on cutting technology based from proto up to high-volume production with a far-reaching qualification standard. The completely automated machinery guarantees short lead times and cost-efficient-production. Materials used include copper, brass, stainless steel, aluminum, titanium and various plastics.

Bakker has an assembly hall and a clean room, class 10.000, where experienced professionals carry out assembly work. All the means required to clean and assemble products are in house available. To develop customer-specific products, Bakker Fijnmetaal uses Hypermill CAM software.

Bakker Fijnmetaal is able to assist from idea, new product introduction (NPI), DFM (Design for Manufacturing) up to release for volume (RFV)

BAKKER FIJNMETAAL BV

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BECKHOFF.NL / IAL

Beckhoff supplies and implements open automation systems based on PC control technology. The product portfolio includes Industrial PCs, EtherCAT I/O, TwinCAT 3 softPLC/softmotion, servo technology and the new eXtreme Transport System (XTS).

Open EtherCAT

With its 'New Automation Technology', which also includes the very popular open EtherCAT field bus and XFC modules, Beckhoff has created a standard for different sectors within the industrial automation. Beckhoff's components and systems are used all over the world in a great diversity of applications, from high-tech machines to intelligent building management systems.

The XTS system combines linear movement with endless rotary movement in one single system, making it less complicated for machine builders. The principle of endless rotary movement is combined with linear movement. With this combination, the user can, for instance, manipulate and place back products on a conveyor system, without interrupting or stopping the product stream. In the XTS system, the manipulators (movers) can be moved independently from one another, enabling an arbitrary variation of distances and speeds of the product. At the same time the process remains continuous, as is the case with a rotary path.

Worldwide on all continents

Beckhoff's head office and production facilities are located in Verl, Germany. Besides the main office, there are many subsidiaries and distributors, dispersed over all continents. Beckhoff is represented in more than 60 countries worldwide.

BECKHOFF.NL / IAL

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BKL ENGINEERING

Smart Engineering Works

BKL Engineering is specialized in developing, manufacturing, testing, certifying and maintaining of customized machines and hoisting and lifting tools. We have gained extensive experience with the machine directive. On request of our customers we can be held CE responsible for the tools they use. Inspection is done according to the international standard ISO/IEC 17020 under supervision of the Dutch Accreditation Council (RvA).

Tooling specialist (lift and shift tools)

BKL has grown to become a true specialist in development and fabrication of specialist 'clever' service tools. We offer both precision engineering and electronic solutions for your production process or machine fleet. Our power is hidden in the way we think with you on solutions. And in using advanced 3D design programs. The result is that our clients do more work with less people. Thanks to that expertise, inspecting, testing and trialling those tools is in safe hands. Not only for the tools we develop and fabricate ourselves, but also for those of other manufacturers.

- BKL inspects and certifies (CE), regardless of where the tools come from.
- Producing tools based on "build to print" (proto and small series).
- We are a true specialist in developing fabrication of specialist 'clever' service tools.

Special Machinery

- Manufacturing machines and sub-assemblies based on "build to print" (proto and small series).
- Designing sensible machines.
- Fully equipped workshop with cleanroom facilities.

BKL ENGINEERING B.V.

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BRAINPORT INDUSTRIES

OEMs competing on the international market for high-mix, low-volume, high-complexity machines have been outsourcing the manufacturing of sub-assemblies and larger non-core submodules to strategic suppliers for quite some time and are now increasingly outsourcing the design and development of the equipment they manufacture as well. What they're doing in fact, is giving suppliers full responsibility for these modules, from design through to manufacturing. This shift is driving suppliers to push their own boundaries in terms of feasibility and responsibility, and to extend their reach across international borders in order to tap into new, foreign markets.

This can be quite challenging for individual suppliers because their companies are often too small or don't have enough financial power. But together, they are strong. Brainport Industries provides a fertile ground and a solid structure for collaborative projects whether they are related to technology, markets or people. It's an environment that provides for a continuing flow of knowledge workers and experts and enables suppliers to increase their output and steadily grow into market leaders.

OEMs who use this chain optimally will be able to serve their customers better. Brainport Industries is the world's leading open supply chain for high-tech companies, and our ambition is to further strengthen and develop it.

Brainport Industries: The global open supply chain for high-tech companies

BRAINPORT INDUSTRIES

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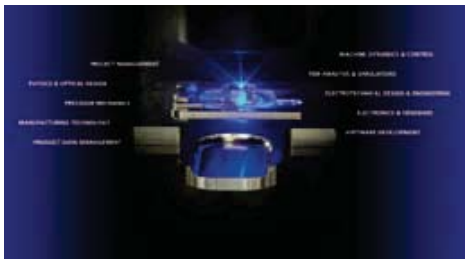
brainportindustries.nl

WWW.BRAINPORTINDUSTRIES.COM

CCM CENTRE FOR CONCEPTS IN MECHATRONICS

CCM Centre for Concepts in Mechatronics is a well-experienced innovative product development company, founded in 1969. CCM has a long experience in inventing original concepts. CCM is able to realize the entire development process up to a finished product or production equipment. Projects that have been realized cover almost the entire field of mechatronic designs and engineering (including optics and information technology).



For our customers we translate technology into technique in the field of high-tech products and systems. Our main focus goes to the appropriate functionality, performance requirements and time-to-market, without ever losing track of product cost price and development costs. In all project stages, from concept development up to realization and sustaining, CCM can be involved and can provide a competent and professional contribution.

Our competences physics, mechatronics, mechanics, electronics, electrotechnics and software enable us to support our customer's success. Commitment, motivation, education and skills of our employees are the solid basis for our business approach.

You are most welcome to visit our stand.

CCM CENTRE FOR CONCEPTS IN MECHATRONICS B.V.

ccm centre for concepts in mechatronics

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CERATEC TECHNICAL CERAMICS

Innovative solutions!

We are specialised in industrial components constructed from technical ceramics since 1983. Our strength lies in the total formula of problem analysis, development, prototyping and production. Ceratec provides professional support in the area of material selection, economical design and backup for incorporation of ceramic components.

We have modern production facilities for processing technical ceramics. We develop and manufacture technical ceramic products for customer-specified applications. A range of standard ceramic industrial components can be promptly supplied.

Production

Alongside various processing techniques, special joining techniques are applied for production of composite products made of technical ceramic and metal. The requisite metal-working processes and assembly activities are carried out in-house. Ceratec produces both small and larger series. Throughout the production process, quality control is carried out in our advanced test room.

Ceramic on the right spot!

Ceratec Engineering guarantees professional support in the area of material selection, economical design and backup for incorporation of ceramic components. We use technical ceramics for products and components in which the material properties produce distinct added value. For instance, wear problems with metal or plastic components can be a reason for calling on the services of Ceratec Engineering. We have modern CAD systems and measuring instruments for the development and production of ceramic components and composite products.

CERATEC TECHNICAL CERAMICS BV

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CONTROLLAB PRODUCTS

With model-based design, you can design machine controllers more quickly and with less errors. Controllab Products will help companies to improve their workflow by implementing this design method. With skilled engineers and own products we offer tailor-made solutions that are unique. With model-based design, extensive use is made of models and simulations to test a design early on. This will result in higher quality designs with less errors. A serious reduction of the design time can be achieved when automatic testing is applied during all stages of a design process.

Controllab can help you to implement model-based design in all phases of the development cycle. This will help you to:

- get a grip on design: better understanding, find design alternatives easier;
- save time: solve problems earlier;
- increase quality: highly automated workflow, early validation.

CONTROLLAB PRODUCTS B.V.

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Contact: Christian Kleijn, Managing Director

DEMCON ADVANCED MECHATRONICS

DEMCON researches, develops and produces high-tech systems and products for our focus areas of high-tech systems and medical devices. Due to our production capabilities, DEMCON can differentiate itself from other suppliers. Our clients receive not only a blueprint but also a working product or system.

DEMCON is a high-end supplier of technologies for the high-tech systems and medical devices markets. Within these markets, our focus is primarily on development and production. DEMCON is highly proficient at applying technical skills and a high level of expertise in order to come up with surprising solutions to complex problems. The knowledge gained in one market enables us to look at problems in other markets in an open and creative manner.

DEMCON ADVANCED MECHATRONICS

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7521 PH Enschede (NL)
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DUTCH PRECISION TECHNOLOGY (DPT)

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

Quality: what we are all about

All DPT members place high priority on the quality of products, components, systems and services. We set our sights a little higher every day, so that we can continue to meet your quality requirements.

Flexibility: always focused on customer satisfaction

Responding professionally, proactively and flexibly to the wishes and needs of our clients. Our staff do just that little bit more to make sure we meet your expectations.

The capacity of DPT: working together lets us tackle a great deal

No project is too large or too complex for us, because we work together extensively and make use of each other's capabilities. Our advanced and innovative machinery makes us a major player in the field of precision-engineered cutting.

Specialty: your one-stop shopping partner

Each of our members has its own specialty. From small to large, from prototype to series production, from plastic to metals, and always with the highest degree of precision: DPT can handle it.

DUTCH PRECISION TECHNOLOGY (DPT)

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DUTCH SOCIETY FOR PRECISION ENGINEERING (DSPE)

Independent branch organization since 1957 for all precision engineers in the Netherlands. Unique community of precision engineers stimulating professional contact and sharing knowledge and experience.

DSPE publishes Mikroniek. This is the only technological magazine from the Netherlands that focuses specifically on engineers and technicians working in the area of precision engineering. Ask for a free copy if you are interested.

DSPE is co-initiator of High-Tech Systems.

DUTCH SOCIETY FOR PRECISION ENGINEERING (DSPE)

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DVC MACHINEVISION

DVC machinevision B.V. is since 2004 the best partner in Vision for OEMs in the Benelux, and supplies them with vision solutions worldwide. This ranges from the unique distribution of A-brand vision components to the development of customer-specific vision modules for food, robot and sport applications.
Investment in technological innovation is key to DVC. Through DVC, the customers will benefit directly from the latest developments in the vision market. Partnership is paramount in our close cooperation with OEMs and system integrators.

Components

DVC offers a wide range of vision components:

- Machine vision software
- 2D and 3D Smart Camera / Embedded Systems
- Industrial cameras
- Framegrabbers
- Lenses
- Lighting

Of course the necessary technical support is provided. Because of our knowledge and expertise each customer is assured of correct and best products for his/her vision solution. Our added value is that we not only select off-the-shelf imaging components technically, but also commercially.

Our exclusive A-brand suppliers are: Sony | Matrox | Basler | LMI Technologies | illunis | and Media Cybernetics. DVC and listed suppliers share the same corporate philosophy: Supplying high quality products at affordable prices with reliable and short delivery times.

OEM vision modules

Besides selling vision components, DVC has developed and implemented several successful customer specific OEM modules. Despite the fact that we could serve various markets because of our extensive technological knowhow, we focus especially on:

- food industry;
- Vision Guided Robotics (VGR);
- sport (top sport) applications.

DVC's OEM modules are created for machine builders whose core business doesn't include the development and production of a camera inspection system.

DVC MACHINEVISION BV

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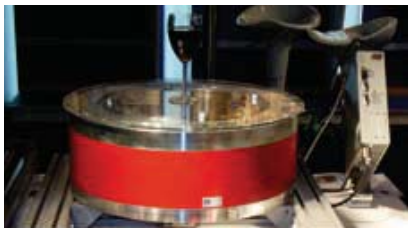
ELTROMAT



Eltromat BV offers you a complete range in drive and positioning components and systems since 1974. You can call our Engineering Department for advise to come to a proper selection of hardware, application software, etc. The commissioning of the supplied components and/or systems can be fully provided by our Service Department. In other words: "one-stop shopping". We guarantee you a quick and smooth processing of your orders.

The Engineering Department within Eltromat is specialized in solving technical drive and control issues, usually in a project-based approach. In essence, they provide you with the necessary expertise to select the right components for your machines and systems. Movements in the right order, at the right time, at the desired speed, accuracy and reproducibility arise from the selection made. Complete electrical machine controllers can be developed, designed and programmed from scrap to high-end, from a simple switch to a complete servo drive including HMI and motion controllers.

Eltromat can accomplish this entire process for you. Furthermore, the possibilities to reuse, modify and/or upgrade (retrofit) existing drives/ controllers are also taken into account. In such situations, it often comes down to the replacement of the components, the supply and connection of new control panels and the development of new application software.

Besides the electronic products, Eltromat has a vast range of mechanical products as well. Examples are linear guides, balls and lead screws, linear units, actuators end gearheads.

ELTROMAT BV, TECHNISCH BUREAU

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ENTERPRISE EUROPE NETWORK | SYNTENS

The Enterprise Europe Network was created in 2008 by the European Commission, with the objective to support in particular SMEs to develop their innovation potential, and to make them aware of European business opportunities and policies. The Enterprise Europe Network brings together close to 600 member organisations from more than 50 countries, and it's the largest network cofinanced by the European Commission to foster innovation and competitiveness of SMEs.

The Network's members are connected through personal contacts and powerful databases, they know Europe inside out, and have been working together for years. So, they have a long experience in offering support to SMEs for their innovation and technology transfer activities, and they can either assist their clients on the spot or put them in touch with the specialised branch in their region.

The Enterprise Europe Network Micro & Nano Sector Group addresses the growing importance of nano and microtechnologies, a sector with huge potential for technology transfer and R&D collaborations and with a rising debate on legislation, policy, development and ethics.Via partner search and matchmaking this sector group helps to link relevant business and cooperation partners together.

Actions include:

- Mapping of regional competences and needs.
- Brokerage events and company missions for business, technological and research partnerships.
- Information and first stop assistance to Horizon2020 programs and other relevant EU initiatives.
- Information on EU policies and legislation and assistance in policy development.

ENTERPRISE EUROPE NETWORK | SYNTENS

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FESTO

Festo is a leading world-wide supplier of automation technology and the performance leader in industrial training and education programs. Our aim: maximised productivity and competitiveness for our customers. Around 100 new products launched every year and some 2,900 patents world-wide are a clear indication of the company's innovative strength.

For our 300,000 customers around the world, we are always close at hand. Festo's 13,500 employees in 176 countries ensure progress in the production of capital and consumer goods – day in, day out. Festo pneumatic and electrical automation technology stands for innovation in industrial and process automation. The principle of sustainability underpins all Festo's activities and vision.

FESTO

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FRAMO MORAT

Your idea - Our drive

Framo Morat (head office in South Germany – Black Forest) develops and realizes drive ideas from spur gears over planetary gears and worm gears, up to complete gear motors.

We are from research & development, prototyping & testing, up to assembling and serial manufacturing your reliable partner in drive technology. Since the founding of Franz Morat GmbH in 1912, gear and drive engineering has been in a continuous state of development at the company's headquarters.

Today with approx. 400 employees, with a worldwide network of distributors, Framo Morat is a globally operating manufacturer of high-quality drive solutions for many industries. With our focus on medical, solar and oem machinery industry we advise our (potential) customers in our core competences of gear, worm gear and drive systems. We look forward to meeting your requirements.

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FRENCKEN EUROPE

Platinum sponsor

For more than 65 years, Frencken Europe B.V. has been serving international OEMs in the medical, semiconductor, analytical and industrial automation markets. We enable our OEM customers to accelerate their innovation, simplify their business and focus on their core activities while we do the design engineering, product development, and production of their complex electro-mechanical assemblies and products.

Frencken Europe directs all mechatronics activities for the Frencken Group worldwide, which include business development, marketing, sales, product development and design and manufacturing engineering. Frencken Europe also acts as the link between Frencken's mechatronics customers and Frencken's global production sites, creating competitive advantage in both products and services.

Creating competitive advantage

Sites

Frencken mechatronics B.V.
- Supply Chain Management
- Vacuum and cleanroom expertise
- Class 10,000 Cleanroom
- High-level mechatronics assembly & testing

Frencken Engineering B.V.
- Mechatronics product development
- Vacuum and cleanroom expertise
- Test tool design and validation

Machinefabriek Gebrs. Frencken B.V.
- High-end precision machining
- Constructional sheet metal fabrication
- High-mix, low-volume flexibility

Optiwa B.V.
- Ultra-precision machining
- Highly automated processes
- Mechanical assembly for vacuum and cleanroom applications

FRENCKEN EUROPE

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GDO

GDO is situated in the south of the Netherlands, close to the German border. Founded in 1899, GDO gathered a very rich experience in the past decades. Starting as a tooling shop for the mining industry, GDO evolved into a specialist machine builder for industrial automation and vision inspection.

The company has over 100 years of experience in tooling, mold making and materials, over 30 years of special machine building experience and over 20 years of vision inspection experience. A logical next step for GDO to take is the (co-)development and delivery of mechatronic and optotronic systems based on a one-stop shop principle. Mainly for that step, GDO expanded its factory with a cleanroom (class 8 and 7), new machinery and an additional assembly area of 1,000 sq. meters.

Over the years the focus on the industries was extended from Automotive and Medical/Pharma solutions to also Packaging, Food and Energy. Nevertheless, the basis in every industry remains the same at all times, involving high-precision and innovative solutions based on a toolmaker's quality. With that GDO is a globally acting company that provides worldwide solutions and service from its locations in the Netherlands, Germany and the US.

GDO B.V.

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GREENTECH ENGINEERING

The core activity of Greentech Engineering is 'managing and conducting the product development process into operation'. We offer both consultancy, engineering services, project realization, specific equipment as well as turnkey commissioned production solutions. We move manufacturing technology into the market by specific equipment and process engineering. Addressing production challenges, yield improvement and supply chain engineering are part of our services.

Mission & Vision

It's our passion to contribute significantly to our customers success by excellent execution of industrialization projects. Market flexibility and agility is enabled by the availability of competences. Innovation is the driving force to new markets and business opportunities. Greentech Engineering, as a flexible organization, provides the competences and management to bridge the gap and accelerate from innovation into profitable operation.

Greentech Engineering is a process-based company, with customers that vary from starter companies moving into the next stage of production to multinationals who need specific support and competence in industrial project execution. We fully manage and direct the customer requirements and project execution. Services will be rendered through process investigations and a step-by-step approach from definition into commissioning.

Headquarters is based in Eindhoven, the Netherlands, in a region known as Brainport. This region is well-known for its strong ties in the high-tech industry environment. We are well connected in this top technology region with suppliers and specialists on high-tech systems.

GREENTECH ENGINEERING

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Ronald Ceulemans, Marketing & Sales Manager

HAUZER TECHNO COATING

World jobs for engineers

At Hauzer Techno Coating engineers can still enjoy their profession. Communication lines are short, employees work independently and in teams. Hauzer offers real world jobs for mechanical, electrical, process and software engineers. You will be working in international teams of colleagues and customers, sharing ideas and developing your expertise. Creative, responsible and flexible are key words for Hauzer employees. Your passion for innovative solutions can be exercised in an entrepreneurial way. The world jobs at Hauzer will take you further.

Hauzer Techno Coating is a fast growing, international high-tech organisation, with 150 employees and branches in Venlo, Yokohama and Shanghai. At our home base in Venlo, we develop and assemble plasma coating systems with vacuum, sputtering and arc evaporation technology, which then find their way around the globe, to customers with notable names. Hauzer operates in a niche market and develops leading technology. The company was founded in 1983 and became part of the Japanese IHI Group in 2008. The IHI Group is a group of 188 companies totalling approximately 27,000 employees.

HAUZER TECHNO COATING

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HEIDENHAIN

Products from HEIDENHAIN ensure that machines and plants work productively and efficiently. Since 1948, when the company began anew in Traunreut, HEIDENHAIN has shipped over five million linear encoders, over eleven million rotary and angular encoders, 460,000 digital readouts and nearly 235,000 TNC controls. Now and in the future, this expertise provides the assurance that HEIDENHAIN was the right choice.

A continuous drive to provide technically superior products in combination with reliability, closeness to the customer, and a practice-oriented frame of mind form the basis of HEIDENHAIN's efforts. HEIDENHAIN has always sought a dialog with science and research on the one hand and with users and customers on the other. Our competence in the area of linear and angular metrology is reflected by a large number of customized solutions for users. These include the measuring and test equipment developed and built for many of the world's standards laboratories and the angular encoders for various telescopes and satellite receiving antennas. The products in the standard HEIDENHAIN product program naturally profit from the knowledge gained in such projects.

HEIDENHAIN NEDERLAND B.V.

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HESSEN TRADE & INVEST

(joint stand)

Hessen Trade & Invest GmbH is the economic development agency of the German State of Hessen. The key task is to secure Hessen as a leading location for business and technology in Europe as well as to further increase the national and international competitiveness.

HESSEN TRADE & INVEST GMBH

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Contact:
Dr. Carsten Ott

ARTEOS

arteos, a leading micro-assembly company, provides:

- micro assembly for customers;
- development of micro-packaging, micro-assembly & micro-products;
- distance, level & gas sensors.

ARTEOS GMBH

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SENSITEC

Sensitec is a leading supplier of MR sensor technology and magnetic microsystems. We offer sensors for precise measurement of angle, length, position, current and magnetic field in industrial and automotive applications.

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Contact: Ellen Slatter, Marketing

BEFORT WETZLAR

Befort Wetzlar is a single-source supplier, geared to fulfilling specific requirements ranging from individual lens elements to precisely fitting system integration, from special optics to complex opto-mechanical sub-assemblies.

BEFORT WETZLAR OHG

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MICRO-PART

micro-part supports all sub-areas of sensor development – from the initial idea to serial product. Our services include the conception, design and delivery of integrated circuits and complete sensor systems.

MICRO-PART GMBH+CO.IS.KG

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INVENIO

As a full-service engineering company invenio performs all phases of the development process – from the initial idea to the finished product, across all sectors. We provide innovative solutions within the category groups development, industrialization, software and consulting. Our service portfolio is completed with the interdisciplinary engineering disciplines Product & Process, Mechanical & Electrical/Electronics, and Hardware & Software. Our committed and highly skilled staff have one priority in this process: your needs.

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THE HIGH TECH INSTITUTE

Gold sponsor

The High Tech Institute (HTI) is a training institute for highly educated professionals in the high-tech industry. HTI offers both profound technical training courses and training courses that focus on developing personal skills and leadership.

Several courses in the portfolio of HTI are internationally renowned, including those for mechatronics, precision engineering, design principles, system architecture and optics.

HTI endeavors to retain its continuity. That is only possible by working together with others and to join forces. HTI does this on a strategic level by collaborating with the associations DSPE and Euspen, the universities of technology of Eindhoven, Delft and Twente, the graduate schools Fontys and Avans, training institutes and companies such as ASML, VDL ETG, NXP Semiconductors, Philips and Sioux.

THE HIGH TECH INSTITUTE

THE HIGH TECH INSTITUTE
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HIGH TECH MECHATRONICS

"We aim to build long term partnerships which will be all about driving your progress!"
We are helping major multinationals but also smaller companies all around the world by being their development partner for new production lines, as well as for improvements and automation of their current production.

Return on Investment

Our starting point is to analyze your situation, regarding product and production technology, demand and operational costs. Then we develop a business case together to achieve the right automation, to optimize the return on investment.

Engineering Solutions

Our team of creative, experienced engineers is passionate to develop the best performing solutions for you. Break-through engineering is simply fundamental for all our special machines.

Make it happen

After giving us your assignment, we make it happen. All activities are performed in-house, from Mechanical, Electrical and Software Engineering to Production of parts in our three factories, Assembly and Servicing.

Fast & Flexible

We are organized to be fast because short lead-time can make all the difference in today's dynamic markets. We are organized to be flexible to be able to incorporate changes in every project phase, in a smart and cost effective way.

HIGH TECH MECHATRONICS B.V.

HTM

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HITTECH GROUP

Hittech Group is a group of centrally controlled independent companies, operating as system supplier. Development, engineering, manufacturing and assembly join in one organization acting as a partner for high-end precision industries, analysis and medical OEM companies, supplying systems, machines, (sub)modules and components.

Hittech Group has ISO 13485:2003 certified facilities. The separate companies within Hittech Group create the flexibility of an independent enterprise, while the Group generates a powerful synergy when operating as one business.

Hittech Group is geared to continuous improvement, in areas of design, product quality, cost or production processes. That's why our partners consider us "Masters in improvement".

HITTECH GROUP

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HOLLAND HIGH TECH

Holland High Tech joins the forces of Dutch high-tech companies, knowledge institutes and government with the aim to stimulate innovation and co-operation in the High Tech Systems & Materials (HTSM) sector, represent interests and strengthen the high-tech ecosystem.

As Holland High Tech, the joint Dutch HTSM sector can also profile itself as a global high-tech player and the Netherlands as 'the place to be' for high-tech companies, knowledge workers, research institutes and students. Joining forces also enables the sector to make better use of the opportunities that emerging markets offer.

Holland High Tech defines and implements the joint program for the sector HTSM. The activities are defined in four program lines:
1 Innovation: joint implementation of R&D activities and growth of SMEs.
2 Human Capital: more and better technicians for the high-tech sector.
3 Supply chain: strengthen the supply chain.
4 International: doing business in and with foreign countries.

Branch organizations and other communities promoting cooperation between industry and knowledge institutes can join the Holland High Tech program by becoming a partner of Holland High Tech. Individual companies and knowledge institutes can participate in the program by becoming a member of a Holland High Tech partner.

Association High Tech NL is founding partner of Holland High Tech. Targeted partners are for example Brainport Industries, Lucht- en Ruimtevaart Nederland (Aerospace Netherlands foundation), AutomotiveNL and Business Cluster Semiconductors.

HOLLAND HIGH TECH

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IAI INDUSTRIAL SYSTEMS

IAI industrial systems in Veldhoven designs, builds and delivers high-tech systems. Our core market is document security, where we supply systems to personalise and secure valuable documents such as passports, identity cards and banknotes. These documents are sensitive to fraud and need to be protected with security features. Advanced technology is needed to apply these security features.

IAI's systems use special laser technology to apply unique data and perforations into the synthetic card of passports and identity cards. An example is the perforated photograph in the Dutch passport, driving license and ID card that you can see clearly when you hold the document to a light source.

Other technologies used in our systems are laser engraving, chip programming, inkjet printing, lamination and vision inspection. IAI's core competences are laser and optics, system design, automation, product handling, machine vision, control software and inkjet printing.

At the moment, IAI employs around 50 people; however we are looking for new colleagues in mechanical engineering, software engineering and field service engineering. If you would like to work in a challenging high-tech, international environment, please visit booth C106 to see our job openings.

The latest Swedish passport has been personalised completely with IAI equipment.

IAI INDUSTRIAL SYSTEMS B.V.

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IBS PRECISION ENGINEERING

Introduction

IBS Precision Engineering is a leading company in ultra-precision metrology components, systems and machines. We are experts in developing unique solutions to the toughest metrology challenges. Our unique products can be found at companies all over the world and our highly qualified and educated engineers have solved complex issues for many well-known companies.

Machines and Engineering

Thanks to our thorough expertise and engineering capabilities we can offer machine, engineering and R&D solutions that guarantee the results down to the very nanometre. This happens custom-made and exactly according to the client's wishes and requirements.

Non-contact measuring systems

Together with strategic partners Agilent and LION Precision, IBS Precision Engineering offers industry leading non-contact measuring systems and solutions. These systems vary from capacitive and inductive systems to laser interferometer position measurement systems.

Machine tool calibration & inspection systems

IBS Precision Engineering offers innovative calibration and inspection systems to measure the accuracy of your machine tool linear and rotary axis and spindle performance. Our inspector solutions are brand new machine-integrated measuring systems that provide a quick and reliable health check of your machine tools during normal operation.

Porous Media air bearings

IBS Precision Engineering offers Porous Media air bearings. Our air bearings include standard and customized solutions varying from air bearings and bushings to air bars and slides.

IBS PRECISION ENGINEERING

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IMOTEC

Imotec develops competitive mechatronic modules, machines and systems for the high tech systems industry. Our core competences are in measurement, monitoring, control and actuation. We build long-term relationships with our customers by delivering value; we aim to let them benefit from lower cost-of-ownership, higher flexibility, shorter time-to-market and sustained quality. To achieve this, we invest in our team; we want our developers to be world class in both expertise and attitude.

The projects that we run are typically centered around innovation and challenging requirements. Challenges occur not only on a technical level, but also in terms of planning and project management. To address these issues appropriately, we work in close cooperation with our customer and employ the SCRUM development methodology where applicable. This helps us to achieve radical improvement as a series of incremental changes.

One of the fields in which imotec has specific expertise, is that of application of piezoelectric materials and components. We have been involved in the development of piezo-based solutions for markets ranging from semiconductor production equipment to medical systems and consumer products. Piezos were applied as sensors, actuators and energy harvesters. Our knowledge in this field has partly been documented by the expert in our team, Jan Holterman, as co-author of the SmartPIE book: "An introduction to piezo electric materials and applications".

IMOTEC B.V.

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IRMATO

Developing your future

Irmato, with 300 dedicated employees and with subsidiaries in the Netherlands, Belgium and Germany, is a multidisciplinary engineering, consultancy and realization company for machinery and professional equipment.

Over the years Irmato has grown from a mono-disciplinary company into a multi-disciplinary project organization. Irmato offers the one-stop-shopping principle. In this concept, Irmato supports its customers in the total product lifecycle by creating the most suited solution.

Through the aid of Development & Engineering, Project Management, Supply Chain Management and Assembly/Realization Irmato reaches this mission.

Irmato offers high-tech competences to its customers:

- Concept Development "from scratch".
- Measurement solutions and the P-ECM technology.
- Mechatronic Development & Engineering of tooling, modules and systems.
- Motion & Design: Advanced design, engineering and analysis.
- Assembly, integration and testing of tooling, modules and systems with the following characteristics : high mix, low volume and high complexity.
- Realization of precision parts: prototyping – repeat series.
- PLM, CAD, CAM, CE and Documentation consultancy.
- Professional and flexible engineering support.

The strength of Irmato is the synergy between these available competences. The right combination of competences will lead to an optimal result. This way Irmato serves a wide market and offers complete solutions to its customers.

IRMATO

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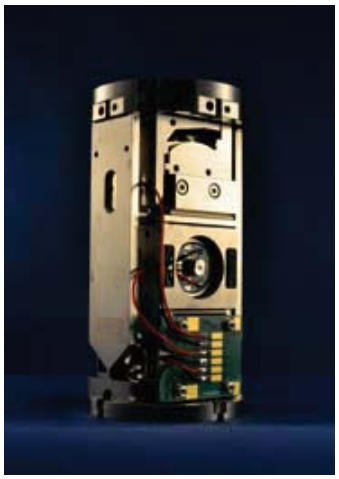
JANSSEN PRECISION ENGINEERING



JPE is an independent engineering group for development and realisation of high-tech machinery and instruments. Especially where accurate and stable positioning performance is involved in the sub-micron area. The company was founded by Huub Janssen in 1991 after several years of experience in the high-tech industry of companies like ASML and Philips. Today, we have built up a team of professionals who are able to find and implement solutions for very challenging engineering requests.

JPE has gained multidisciplinary knowledge of technical issues at every level. From system level down to component level, from definition and design, up to prototyping and qualification. By following a systematic approach with high involvement, quality and efficiency are guaranteed. Although turn-key projects are our strength, JPE can also participate in any development team to introduce the required expertise.

We develop high-end opto-mechanical applications to be used in deep vacuum as well as cryogenic environment.

Our developments typically find their way in international markets, like:
- semiconductor industry;
- astronomy and space;
- scientific experimental instruments.

JANSSEN PRECISION ENGINEERING

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KMWE

KMWE is a supplier and partner for the High-tech Equipment Industry and Aerospace. KMWE is specialized in the High-Mix, Low-Volume and High-Complexity machining of functional critical Components and the assembly of fully tested mechatronic Systems. KMWE is a global player located in Eindhoven, Malaysia and Turkey.

More than 55 years of experience, an international supplier network, over 320 motivated employees and a continuous drive for Excellence enable us to fulfill the highest demands of our customers.

Precision Components (sites in the Netherlands, Turkey and Malaysia) is specialized in the fully automated 24/7 machining of function-critical Components. The high level of automated machining of a high mix of products in small batchsizes requires a well thought-out machining strategy and high level of process control.

Precision Systems (sites in the Netherlands and Malaysia) is specialized in the assembly of high-quality mechatronic Systems, often assembled in a clean or cleanroom environment.

KMWE Projects supports the customer in the engineering of parts and modules and the realization of the best Total-Cost-of-Ownership solutions during the complete Product-Life-Cycle. The engineering processes are based on the proven aspects of QLTC. KMWE Projects operates internationally as support for all operational units of KMWE Components and KMWE Systems.

KMWE

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LAMERS HIGH TECH SYSTEMS

Lamers High Tech Systems has been a leading supplier in the semiconductor, PV solar, aerospace, pharmaceutical, and other technology driven markets for over 25 years. It is our mission to bring ultra-high purity fluid handling, conditioning, and delivery solutions to our customers that minimize the total cost of ownership while maintaining the highest levels of quality and reliability.

Lamers HTS is headquartered in Nijmegen and has an additional production site in Kerkrade. Both facilities include certified orbital stainless steel welding, plastic welding, and assembly in cleanrooms up to class 10 for high-purity manufacturing. In addition, Lamers provides R&D, design engineering, and the global installation and commissioning services to ensure our customers' systems start-up in the most efficient and productive manner.

Key competences in design and manufacturing

- 3D design of modules for gases and chemicals for OEMs or institutes.
- Design, installation and qualification of infrastructures for gases and chemicals.
- Orbital stainless steel gas tube and pipe welding under cleanroom conditions.
- Turn-key special projects for advanced industries.
- Full set of qualification and certification tools, like RGA, TOC, THC, leak check and pressure test.

LAMERS HIGH TECH SYSTEMS

De Vlotkampweg 38
6545 AG Nijmegen (NL)
T +31 24 3716777

info@lamershts.com
WWW.LAMERSHTS.COM

LEMO CONNECTORS BENELUX

LEMO Connectors Benelux is responsible for servicing the LEMO Group's customers in the Benelux. Founded in 2005, LEMO has grown steadily to become a market leader for circular connection solutions in the Benelux, and our services include technical support, cable assembly, design facilities, customer sales services and service to provide the complete solution. Due to our flexibility we are able to react on customer needs and deliver in short lead-time. Electrical, Coax, Triax, Fluidic, High Voltage, Thermocouple, Fibre Optic and various combinations of the mentioned contact configurations are our quality.

LEMO Benelux aims to achieve industry excellence in the design, manufacture and sale of products and services to optimise responsiveness, lead-times, quality and price. We strive to develop long-term relationships with customers and suppliers, and our record to date is a testament to that policy.

LEMO CONNECTORS BENELUX

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MASÉVON TECHNOLOGY & VERNOOY VACUÜM ENGINEERING

Masévon Technology

Masévon Technology is a fully equipped high-tech system supplier, specialised in the development and realization of complex (mechatronic) systems, modules and machines, combining decades of experience with new techniques and a broad capacity in engineering, manufacturing and assembly.

Both as a first-tier supplier to international OEMs and a supplier of customer-specific solutions, we provide our customers the professional services they demand, from the first step of engineering up to commissioning at the production site.

Vernooy Vacuüm Engineering

Vernooy Vacuüm Engineering is a specialist in highly accurate and extremely complex parts and assemblies for vacuum systems used in the Semiconductor, Solar and Process Industries as well as Research Institutes. Competencies range from engineering through realisation to leak-testing of systems with vacuum chambers in sizes up to several m^3.

A broad range of CNC milling and turning equipment as well as vacuum-specific welding capabilities are available in-house. Wet cleaning processes are on hand and if required, assembly can be done under cleanroom conditions.

Masévon and Vernooy, together with Machinefabriek Tuin, are part of the Triumph Group, a unique combination of high-tech companies. Through intelligent collaboration and networking of its expertise, the group has developed into a highly flexible quality manufacturer of machinery and equipment for high-demanding markets.

MASÉVON TECHNOLOGY B.V.

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VERNOOY VACUÜM ENGINEERING B.V.

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MAXON MOTOR BENELUX

maxon motor is a leading worldwide supplier of precision drives and systems of up to 500W output. maxon motor ag, with its head office in Switzerland, has more than 2,000 employees and sales offices in forty countries. With her drive solutions, maxon motor serves markets such as the semiconductor industry, medical technology, laboratory and measurement technology, robotics, machine construction, industrial automation, the automobile industry and the air and space industry. The drives are characterized by their high power density: small in size but delivering high power. That makes lightweight applications possible, such as an insulin pump that a diabetes patient can carry on his or her belt.

maxon motor benelux delivers the complete modularly built maxon assortment: from dynamic and powerful DC motors and special transmissions to intelligent compact drives and ceramic and metal injection molding components. In addition to reliable and robust products, maxon motor benelux delivers knowledge of precision drive technology, can take responsibility for parts project management and handles the necessary assembly, certification and packing of the drive systems. maxon motor benelux offers customer-specific, 'plug & play' solutions.

MAXON MOTOR BENELUX BV

maxon motor
driven by precision

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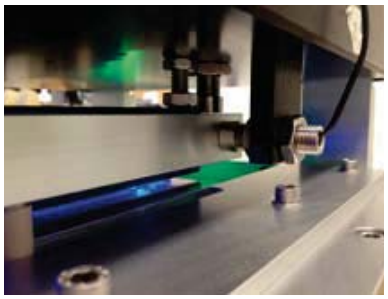
MI-PARTNERS

MI-Partners is a centre of expertise in the field of mechatronics and is actively involved in the development of high-tech mechatronic systems. MI-Partners is a fast growing organization capable to react fast, flexibly and competitively to customers' demands. International customers can be found in the following markets: semiconductor, automotive, medical, inspection, printing and imaging. An enthusiastic team of experienced project leaders, system architects and highly educated engineers work together to satisfy the customers' needs. High-end innovative solutions are a result of a fresh perspective at the problem and the links between projects in other markets.



With the support of prof. dr. ir. Maarten Steinbuch (TU Eindhoven) and prof. dr. ir. Jan van Eijk (TU Delft), MI-Partners has access to the newest technologies from the academic world. MI-Partners is also working on in-house projects such as active vibration isolation and overactuated technology. These in-house activities are used to strengthen our competences and can have a future spin-off in new businesses. All our activities take place at the MI-Partners facility in Eindhoven, with a cleanroom environment available and a large variety of measurement and analysis tools. Therefore, MI-Partners is your partner in Mechatronic Innovations.

MI-PARTNERS B.V.

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MTA

MTA is an innovative, flexible and high-tech company specialized in the development and manufacturing of mechatronic machines and systems. Our clients are OEMs in the Packaging, Food, Graphics and High-Tech systems industries. They have high demands when it comes to quality, flexibility, innovation and cost-management, and have found a reliable and dedicated partner in MTA.

Expertise and know-how

Our Development & Engineering division distinguishes itself by its ability for innovation, knowledge of production techniques and technological expertise in the field of mechatronic systems.

Cost control

Our own production facilities in the Netherlands and Romania, together with the Global Sourcing System, allow us to offer our clients an optimum combination of quality, turnaround time and cost.

Workmanship

Our team of qualified staff ensures efficient and high-quality system assembly with fully integrated hardware and software applications.

Delivery reliability

As a leader in chain management, we are also innovative with respect to the organisation of our operational processes. Our standardised and efficient work methods ensure a high level of flexibility and reliable delivery performance.

Quality

Quality is carefully monitored during and after assembly and is recorded in real-time in our Assembly Quality System. This results in a continuous improvement cycle in efficiency and quality assurance.

MTA

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MTSA TECHNOPOWER

MTSA Technopower develops, designs, builds, and maintains customer-specific equipment, installations and special machines for global customers. We offer innovative total solutions, by combining processing technology, mechanical engineering, electrical engineering, automation and instrumentation.

MTSA manufactures parts, mechatronic modules, and complete systems as one-off or in small or medium series. MTSA has a machine factory, construction workshops, measuring room, assembly areas, and a clean room.

Traditionally, we act on your drawings and specifications. Additionally, we can optimise your design in production method and cost price. The process is tackled using a project-based approach. Extensive experience with metallurgy, electronics and process technology makes MTSA a knowledge partner for new systems and system optimisation. The challenge is in the multidisciplinary approach that looks beyond the borders of traditional and existing possibilities.

We are an integral part of your business chain. Therefore, we will balance your production peaks, ensure reliable stocks at the lowest cost and risk, and manage the suppliers in terms of quality, reliability, technology and price. We use a production planning and control system, with instant overview on the progress of all orders.

After delivery, MTSA would be happy to take care of your repair, spare parts and maintenance activities.

MTSA TECHNOPOWER BV

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Contact: Ko van de Ven

MULTIVALENT PLATING & ETCHING

Layers for corrosion resistance, abrasion, adhesion, adsorption, conductivity, hardness, reflection, shielding, strengthening, solderability

Multivalent with its PGE roots is specialised in electrochemical treatment for High-Tech Industry and Aerospace. (Quality system AS9100 & ISO9001). Our key competences are precision electroplating, pickling, electrolytic and chemical polishing, chemical treatment, electroforming and etching. We work in the range from micron to meter and treat all kinds of materials.

All processes, techniques and knowledge at a young, fast growing company near Eindhoven:

- Fast delivery.
- Small series and prototypes.
- High-quality electroplating techniques.

Our in-house capabilities:

- Pickling, passivation (dichromate, AMS 2700), cleaning and packaging.
- Chemical and electropolishing of stainless steel (ASTM-B912), copper alloys, aluminium, fernico.
- Nickel: matte (AMS-2424), bright nickel, electroless nickel (AMS-2404), nickel-PTFE.
- Copper: matte, bright, electroless.
- Tin: matte, bright.
- Precious metal electroplating: silver, pure gold (AMS-2422, ASTM B488-95, ISO 4523), gold-cobalt, immersion gold, platinum, indium, palladium (ppf), ruthenium, palladium nickel.
- Miscellaneous chemical treatments: blackening of stainless steel (MIL-DTL-13924) and copper alloys, electroplating of plastics, ceramics and additive manufacturing parts.
- Etching: metal on a carrier/isophase, aluminium, titanium, tungsten and molybdenum.
- Stripping: selective metal removal, removal of surface contamination, removing micro burrs, smoothening or roughening the surface or reduce wall thickness. Also at spots where mechanical treatment is not possible.
- Other: contract R&D, projects, consultancy & engineering, analysis and testing in a fully equipped lab, special fabrication.

Your demands, our processes

MULTIVALENT PLATING & ETCHING

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NANONEXTNL

Micro and nanotechnology will make a significant contribution to resolving major societal questions such as keeping an ageing society healthy and keeping our environment liveable in a changing climate. The basis for being able to provide this contribution lies in the creation of an open, dynamic and sustainable ecosystem for research and innovation with which the Netherlands can continue to play its leading role in the world, and can extend this role further, in micro and nanotechnology. This ecosystem is created by initiating and guiding research projects within the themes.

NanoNextNL is a consortium of more than one hundred companies, universities, knowledge institutes and university medical centres, which is aimed at research into micro and nanotechnology. The total sum involved for NanoNextNL is 250 million euros, half of which is contributed by the collaboration of more than one hundred businesses, universities, knowledge institutes and university medical centres, and the other half by the Government of the Netherlands.

NANONEXTNL

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NATIONAL INSTRUMENTS

Graphical System Design

Engineers and scientists request tools that accelerate their productivity and facilitate innovation and discovery. National Instruments' graphical system design approach to engineering provides an integrated software and hardware platform that speeds the development of any system needing measurement and control. NI's integrated platform finds many applications, including:

- Medical devices for tumor treatment.
- Asset monitoring of wind turbines, rail infrastructure and power distribution.
- Hardware-in-the-loop testing.

Off-the-shelf and customizable

In all the above cases, engineers needed a high-performance customizable, yet off-the-shelf, embedded platform. The off-the-shelf solution simplifies development and shortens time-to-market when designing advanced control, monitoring and test embedded systems. NI RIO hardware, which includes CompactRIO, NI Single-Board RIO, R Series boards and PXI-based FlexRIO, features an architecture with powerful floating-point processors, reconfigurable FPGAs and modular I/O. Engineers can program all NI RIO hardware components with NI LabVIEW to rapidly create custom timing, signal processing and control for I/O without requiring expertise in low-level hardware description languages or board-level design.

NATIONAL INSTRUMENTS NETHERLANDS BV

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NIJDRA GROUP

The Nijdra Group is a professional supplier specializing in high-quality precision components, complex (sub)modules and complete systems for the high-tech industry. We make things hassle-free for our clients, from engineering, manufacturing, assembly and testing to supply chain management.

The Nijdra Group consists of the following business units:
1 Fine Mechanical Industry (turning, milling & grinding)
2 Nijdra Special Products (engineering & assembling)
3 Medical Product Technology (prototyping & orthopaedic/orthodontic implants)

The Nijdra Group is ISO 9001, ISO 14001 and ISO 13485 certified.

Thanks to our extensive experience (since 1974) in the high-tech industry, we are capable of providing added value in any phase – from development to production of assembled and tested modules and machines. Furthermore, we can support our clients with the design and production of a prototype as well as with the development from a prototype to series production and assembly. We draw on our wide expertise in the field of manufacturability, scope of tolerance, use of materials, surface treatment, cost reduction, excellent quality and efficient assembly, to achieve the optimum results for our clients.

Precision is our profession, service is our passion!

NIJDRA GROUP

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NOBLEO TECHNOLOGY

Noblesse oblige

Nobleo is a consultancy and engineering firm with a great deal of experience. Nobleo stands for 'noblesse oblige': talent is an obligation. The 50 employees working for Nobleo belong to the best specialists in their field.

Nobleo Technology provides engineering services and consultancy in the area of mechatronics, dedicated motion systems and advanced system and equipment design. The Nobleo Technology team includes experts on motion control, system dynamics, embedded software, visual sensing and actuation. All this combined with a V-model design methodology and over 100 man-years of experience.

'Talent is an obligation' means making the most of the talents you were born with. Nobleo enables its employees to continuously develop their knowledge and experience. To this end, they receive personal and technical coaching from Nobleo and are trained to utilise their talents to the maximum.

Our talents realise that to stay at the top, they can never stop learning. Our talents think ahead – about their personal development and about making our clients' work environments and/or projects successful. This makes Nobleo the ideal expertise partner.

Noblesse oblige, talent is an obligation

NOBLEO TECHNOLOGY

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NORMA GROEP

Your System Integrator

Norma employs more then 400 motivated people and has a strong position as a 'low-volume, high mix' system supplier with a focus on ultra precision. We offer our OEM clients service throughout the complete value chain. From development, production, assembly and testing to service.

Some of our capabilities

- Development and construction
- Configuration management
- Ultra-precision machining
- Precision machining
- Dipbrazing and vacuum brazing
- Machining of alloys, titanium, inconel
- Module assembly, in clean room conditions
- Ultra-clean vacuum production
- Design and manufacture of composite products and assemblies
- RF expertise
- Complex cabling & electrification

Fields of experience

- Semiconductor industry
- Defence industry
- Aerospace industry
- Medical industry
- Consumer Lifestyle industry

NORMA GROEP

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NTS-GROUP

Platinum sponsor

The NTS-Group assumes responsibility for the development, creation and assembly of opto-mechatronic systems and mechanical modules for leading original equipment manufacturers (OEMs), so that these clients can focus on the marketing, sales and servicing of their products.

The NTS-Group has deliberately incorporated the manufacturing of critical components into its organisation. This makes it possible to maintain optimal control of production feasibility, costs and logistics performance. Professional skill knowledge and know-how complement each other within the group. Thanks to our companies in the Netherlands, the Czech Republic, Singapore and China, we can also respond flexibly to market demands. This unique concentration of strength on an international level means that our customers can deliver high-quality machines to their market in a shorter turnaround time and at competitive prices.

The NTS-Group aims to become partner of choice for opto-mechatronic modules and systems.

NTS-Group: Accelerating your business

NTS-GROUP

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OCÉ-TECHNOLOGIES

Océ-Technologies in Venlo is the product creation center of the Océ group – 2,400 employees work in Manufacturing, Logistics, Research & Development and corporate departments. A career at Océ can take you anywhere. At Océ Research & Development (R&D) new technologies, product concepts and software are developed. R&D jobs at Océ in Venlo take you to one of the top ten R&D sites in the Netherlands. It employs around 800 people, most of whom are university graduates. Another 800 R&D staff work in Océ laboratories in Belgium, Germany, France, Romania, Japan, Singapore, Canada and the United States, offering plenty of room to spread your wings.

About Océ and Canon: Stronger together

Canon and Océ have joined forces to create the global leader in the printing industry. For our customers this combines Canon and Océ technology with the support of the Océ direct sales and service organizations.

Imagine you, Océ and Canon

We are looking for (experienced) candidates with a background in Electrical Engineering, Mechatronics and Informatics. For our current openings go to: www.ocecareers.com.

OCÉ-TECHNOLOGIES B.V.

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careers@oce.com
WWW.OCECAREERS.COM

Contact: Nynke Adema,
Corporate Recruiter

OMC

Similar to the High Tech Campus in Eindhoven in the field of R&D, the Open Manufacturing Campus wants to bring together high tech manufacturing companies on the site of Philips Turnhout to realize the 'Factory of the Future' through open innovation in engineering and manufacturing concepts and processes. This is based on the available unique ramp-up competencies and occurs in line with the New Industrial Policy of Flanders.

OMC

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DE ONTDEKFABRIEK

'The Discovery Factory' (De Ontdekfabriek) is based in the heart of the technology region 'Brainport Eindhoven' in the Netherlands. The goal of The Discovery Factory is enlarging enthusiasm for technology among children and students. This helps them thinking about their own future and increases supply of technically skilled human resources on the labour market.

To do so, The Discovery Factory takes a very unique approach, based on storytelling. The adventures of 'The Inventors' inspire youngsters creating their own inventions. These adventures are stories to be read by teachers in schools or films to be watched in the theatre of The Discovery Factory in Eindhoven. Technical students and companies are involved to create the (film) adventures and workshops. The attached educational materials and inventors competition guarantee a positive experience for youngsters and challenge them to create their own inventions and present them in inventors competitions.

Also for companies a visit to The Discovery Factory is worthwhile. The various workshops in the former Philips factory are inspiring and together with conference and catering facilities make every company event into a success.

DE ONTDEKFABRIEK

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WWW.DEONTDEKFABRIEK.NL

PHILIPS INNOVATION SERVICES

Cosponsor

Driving innovation through technology

Philips Innovation Services is a highly creative technology-based organization based in the Eindhoven region of the Netherlands – voted 'Intelligent Community of the Year 2011' by the Intelligent Community Forum. By delivering unique expertise in all areas of the innovation process – from concept creation, product development, prototyping, small-series production and industrialization to quality and reliability, sustainability and industrial consulting – we help high-tech companies and knowledge institutes to accelerate their innovation. Our in-house access to some of the world's most advanced process development, clean-room and test & measurement facilities positions us at the cutting-edge of technology development.

Engineers, scientists and business professionals at Philips Innovation Services work with new technologies and methodologies at the highest level. They apply their expertise in multidisciplinary teams, building on customer knowledge, end-user insights and new technology developments to deliver meaningful 'never been done before' solutions that positively impact customers and end-users. Hands-on and project oriented, they enjoy the end-to-end responsibility and direct customer contact that leads to genuine and visible appreciation for their success.

A world of opportunity

If you welcome the learning opportunities that come from working in multidisciplinary teams on business and technology challenges in wide-ranging applications, industries and cultures, Philips Innovation Services offers the ideal environment to grow your career and take it in the directions you want to go.

We'll give you the challenges you need to make everyday a rewarding new experience and the resources you need to get things done.

PHILIPS INNOVATION SERVICES

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PHILIPS

For jobs Philips Innovation Services:
WWW.INNOVATIONSERVICES.PHILIPS.COM/CAREERS

For jobs Philips:
WWW.PHILIPS.COM/CAREERS

PM-BEARINGS

When excellent quality and high performance precision and accuracy is needed. PM-Bearings is well-known as the specialist in the manufacturing of precision linear bearings and systems. Beside our standard product line, over 50% of our products are custom-specific built and all the components are being produced in-house. We cover the complete process from start to finish, from R&D to series production and integration of linear bearings, guidance systems, nano-positioning stages, mechatronic (vacuum) modules and many more by using high-precision machinery and micro assembly. Markets to which we supply, include: the semiconductor, analytical, aerospace, synchrotron, defence, measuring, medical and optical industries throughout the world.

PM-Bearings competences

- System Realization from R&D to mass production
- High-Accuracy manufacturing with, among others: cylindrical grinding, surface grinding, 5-axis milling, lapping, ECM
- Linear Technology
- Wafer Inspection & Nano Lithography modules
- Mechatronic Nano-positioning modules
- Machining of exotic materials like Ceramics, AMC, Titanium, Invar36 and Carbon
- Piezo Technology
- Ultrasoon Cleaning
- Frame Building
- Electrochemical Machining technology
- System Assembly, also in cleanroom conditions (ISO 5 / 6)
- UHV production
- Surface cleaning & coating
- Sheet Metal working

PM divisions

- PM-Bearings – Linear Bearings
- PM-Motion – System building & System integration
- PM-Aerotec – Machining, Assembly, Sheet Metal working
- PM-Surface – Surface cleaning & coating

PM-BEARINGS B.V.

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PRODRIVE

Prodrive success story

Over 20 years, Prodrive has rapidly grown into a unique electronics and mechatronics total solution provider. Prodrive delivers most competitive customized solutions by integrating a strong in-house engineering force of around 300 highly educated engineers with in-house world-class automated manufacturing. Our customers benefit from innovative concepts, lower costs, higher flexibility and sustained quality.

Technology areas

- Digital and Video Processing
- Power Electronics
- Motion Control
- Mechatronics
- Linear Motors
- System Design

Application markets

- Semicon
- Industrial
- Medical
- Agriculture
- Automotive

2012 Rewards

- FD Gouden Gazelle 2012 (Fastest growing company Noord-Brabant, NL)
- Dutch Industrial Suppliers Award 2012 (Achievement Award)

PRODRIVE B.V.

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PRODUKTIONNRW

Strong in North Rhine-Westphalia: Mechanical Engineering

North Rhine-Westphalia is home of many innovative and efficient companies. With about 200,000 employees and a turnover of 44.1 billion euros the mechanical engineering branch is a cornerstone of the North Rhine-Westphalian industry.

Many companies are acting in high-tech-areas. Quite often they arose from universities like RWTH Aachen, Ruhruniversität Bochum, TU Dortmund, etc. or are working in close relation with them. Their business is based on various industries covering Microtechnology, Productronics, Automation, Measuring & Testing Technology, Environmental Engineering up to Bio- of Medical technology. A success factor for these companies is the collaboration in networks and clusters like ProduktionNRW or the respective VDMA associations or equal international structures.

ProduktionNRW is the cluster for mechanical engineering and production technology and is managed by the German Engineering Association in North Rhine-Westphalia, VDMA NRW. ProduktionNRW provides a platform that dovetails companies, institutions, and networks along the value chain and initiates new partnerships.

With its variety of activities and measures ProduktionNRW further strengthens the sector's position, thus enhancing existing competences and top performances and pooling synergies to strengthen the branch's role as motor of the North Rhine-Westphalian industry. ProduktionNRW aims at turning North Rhine-Westphalia into the leading location for mechanical engineering.

PRODUKTIONNRW

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ROODMICROTEC

With 40 years' experience as an independent value-added microelectronics and optoelectronics service provider, RoodMicrotec offers a one-stop shopping proposition to fabless companies, OEMs and other business partners.

RoodMicrotec has built up a strong position in Europe with its powerful solutions. Its services comply with the highest industrial and quality requirements as demanded by the high-reliability/aerospace, automotive, telecommunications, medical, IT and electronics sectors.

'Certified by RoodMicrotec' concerns certification of products inter alia to the stringent ISO/TS 16949 standard for suppliers to the automotive industry. The company has an accredited laboratory for testing and calibration activities in accordance with the ISO/IEC 17025 standard.

The value-added services include failure & technology analysis, qualification & monitoring burn-in, test & product engineering, production test (including device programming and end-of-line service), ESD/ESDFOS assessment & training, quality & reliability consulting, supply chain management and total manufacturing solutions with partners.

RoodMicrotec has facilities in Germany (Dresden, Hannover, Nördlingen, Stuttgart), the UK (Bath) and the Netherlands (Zwolle).

ROODMICROTEC GMBH

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SEGULA TECHNOLOGIES NEDERLAND

Let's shape the future together

SEGULA Technologies Nederland BV is part of the international engineering group Segula Technologies with headquarters in France. With over 7,000 employees worldwide, Segula is a strong player in the field of engineering, consulting and associated services. Segula is a project organisation working for industries (OEM) in amongst others automotive, healthcare and high-tech components & systems industry.

Segula Technologies guides its clients throughout the full life cycle of the product, from initial design to operational maintenance. The company offers clients the possibility to take on one or several stages of their development process up to and including prototypes, and if necessary supervising the start-up of the production process. Operational performance, a demand for quality and respect for our commitments are the key values of our group, values which guarantee our customers' trust and define our role as a major engineering company.

SEGULA TECHNOLOGIES NEDERLAND BV

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SENSOR UNIVERSE

Sensor Universe is an initiative of the municipality of Assen, the Province of Drenthe and ASTRON.

Sensor Universe links entrepreneurs, governments and knowledge institutes in the field of high tech sensor systems with the goal to promote economic activities in the Northern Netherlands. Sensor Universe does this in cooperation with its stakeholders: the Province of Drenthe, the municipality of Assen, INCAS^3, ASTRON, Hanze Institute of Technology, and the University of Groningen.

So if you are looking for new business opportunities in relation to high tech sensor systems? Please visit our stand no. A5 on the 24th and 25th of April.

SENSOR UNIVERSE

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WWW.SENSORUNIVERSE.COM

SETTELS SAVENIJE VAN AMELSVOORT

Founded in 1987 and located in Eindhoven, Settels Savenije van Amelsvoort is one of the leading firms in the development of high tech products and high tech equipment. We focus on R&D, Strategic Management Consultancy and Recruitment.

Research, Development & Engineering

The core of technology within Settels Savenije van Amelsvoort is mechanical engineering, process modeling and process engineering. Our company has in-depth knowledge of and experience in analyzing, specifying, developing and engineering high tech products, processes and equipment. We are experts in the translation of the specifications of complex physical processes into working mechanical products. For example, we combine mechanical modeling with thermal modeling in vacuum and molecular gas flows. Using our creativity, we translate complex challenges into simple solutions.

Strategic Management Consultancy

In our consultancy practice, we audit technology enterprises and/or their departments. We implement and manage (organizational) change to improve their performance.

Our board of directors is composed of ir. John H.M. Settels and ir. Sven Pekelder; ir. Guustaaf P.W. Savenije is member of our supervisory board.

Group members

- The High Tech Institute – leadership in technology and innovation.
- Bakker Fijnmetaal BV – development and manufacturing of ultra-precise metal parts and static assemblies.

SETTELS SAVENIJE VAN AMELSVOORT

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SILICON SAXONY

Silicon Saxony e. V. is a German trade association for the semiconductor, microsystems, software and photovoltaic industries. We are connecting 300 commercial enterprises, research institutes, universities and public institutions. The competencies of our members represent the entire value creation chain of the microelectronics industry. In addition, the network is expanding to sectors as the photovoltaic and software industries.

As a continuously growing and vital high-tech network, we understand ourselves as a communication and cooperation platform for our members. This promotes and stabilizes the economic development of our member companies. Intelligent partnerships among them enable knowledge transfer, synergies, business relationships and promote innovative power. Silicon Saxony makes a vital contribution to the active site marketing as well as the creation of networks among European microelectronics venues (e.g. Grenoble and Eindhoven).

The Silicon Saxony cluster is Europe's leading and the world's fifth largest cluster for microelectronics /ICT. A unique concentration of approx. 2,100 companies with more than 51,000 employees providing extensive knowledge and expertise in the sectors microelectronics and nanoelectronics, nanotechnology, organic & printed electronics, energy-efficient systems, telecommunications technology, and integrated sensor technology is found in the region between Dresden, Leipzig and Chemnitz.

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SORAMA

Sorama helps product developers reduce and optimise the sound level of their products in order to meet regulatory requirements and differentiate their product offering from the competition. To fulfil those needs, Sorama uses a patented technology to visualise the sound field around and vibrations on manufacturers' products. The result is a razor-sharp view of sound sources and dynamic behaviour in 3D and through time.

After having announced the prototype of the 1,024-channel sound imaging camera at the BCE2012 event, Sorama will offer visitors of the HTS event an exclusive chance to pre-order the commercial version of the Cam, to be launched in Q4 of 2013.

The Sorama propositions

- Consultancy – Our sound imaging consultants can measure your product and advise on how to assist your team in solving your noise and vibration challenges.
- Products – Purchase one of our measurement systems and have a sound camera at your disposal at the most critical moments in your R&D process.
- Co-development – The possibilities with our sound imaging technology are endless, we surely haven't found the boundaries yet. We are always interested in co-development opportunities.

SORAMA

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TECHNOLOGY FOUNDATION STW

Technology Foundation STW's basic strategy is to call for proposals from the field. These always concern innovative research with a potential for utilisation, in the form of independent projects and programmes (related projects around one subject). The chance of utilisation is increased by the compulsory utilisation section in each proposal, where the researchers must state how they will realise the use of knowledge by third parties. Each proposal is subjected to the same critical review process by independent experts in which scientific quality and utilisation carry equal weighting.

Enabling new technology

Furthermore, each proposal must always be accompanied by a statement of intention from actual or potential users. Representatives of these users sit on the User Committee appointed per project and supervise the research. This approach applies to all of STW's activities.

About half of the STW budget goes to the Open Technology Programme. This consists of independent projects. The other half of the budget is available for a number of other types of funding. Within Perspective, programmes of interrelated projects are funded. Perspective programmes are strongly characterised by consortia of research institutes and users. Within Partnership, collaborative programmes are formulated around explicit research questions from companies. In a specific Partnership programme STW usually recognises a single company as a partner. Research proposals are also called for via the individual researcher funding instrument Innovational Research Incentive Scheme of NWO, and in the specific case of valorisation from the funding instrument Valorisation Grant for entrepreneurial researchers.

TECHNOLOGY FOUNDATION STW

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Enabling new technology

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TECNOTION

Tecnotion is the global authority on linear motor technology. We are the world's only unbundled manufacturer of linear motors and specialize solely in the development and production of linear motors. Because of this, our expertise, customer service and product quality are unmatched. We have a global presence, which ensures short delivery times and high quality support, wherever you are located.

Our highly skilled sales and application engineers are at your disposal. They will help you from your initial prototype all the way to the application of our products and beyond.

Whatever your needs are, you can count on Tecnotion as a solid, reliable partner.

TECNOTION

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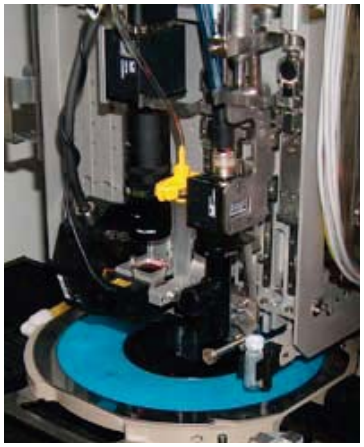
TEGEMA

Brilliant ideas, great solutions, successful products...

TEGEMA widens your scope!

As a full-service development partner, TEGEMA offers you a wider scope and new opportunities through close co-operation. Our people ask the right questions, remain critical and point out new possibilities. We want to take your ideas to the next level – and far beyond.

Our varying multidisciplinary teams never travel the same road twice. Constantly challenging their creativity results in the best solutions for clients. Thinking 'out of the box' keeps our minds fresh, which leads to innovative applications and products. Our teams have decades of experience to share in project-oriented product and system development, for established firms, start-ups and spin-offs. Whenever necessary, we work closely with our network of specialist companies and institutes.



TEGEMA develops, innovates and realises products, processes and systems, from idea to a functional model, prototype or pre-production series. We can take care of production, assembly, tooling, test equipment, realisation and commissioning. Our technicians take on the most complex and challenging client questions and work on their own projects, which together forms our technology roadmap, tuned to trends and market demand.

High Tech Systems – Medical Technology – Factory Automation – Automotive Systems – Maritime Applications

TEGEMA

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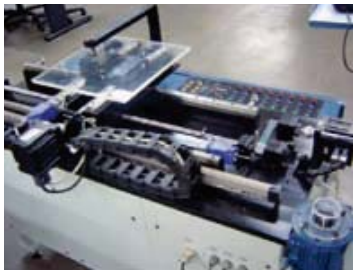
TELEREX

Telerex Motion Solutions specializes in simple to very complex motion problems, with all the knowledge to be a valuable sparring partner for you, from feasibility stage to production. On-site support or testing capabilities within our Competence Center are components of our total service, as well as a thorough logistics and financial services. Depending on your requirements in the field of electrical, mechanical and other properties, Telerex will work with you to select the right motion technology. In doing so, we also take into account aspects such as market and technology trends, availability and price.



Telerex Motion Solutions and Eltromat have been teaming up so that they can now represent their many leading international manufacturers of motors, controllers, gearboxes, brakes, sensors and intelligent integrated products. This experienced consultancy team, Telerex Motion Solutions and Eltromat, is combining their knowledge to provide you, as our client, with the best solution for your requirements like innovative drive and positioning systems.

Clients from various industries have already effectively utilized our control expertise in the fast realization of dedicated solutions for highly demanding environments.

Our benefits

- Broad range of mechanical and electrical motion products
- Experienced hardware & software engineering team
- Internal lab with test facilities
- Service & support on location
- Stock management
- Project management

Markets

- Packaging, labeling and printing machines
- Agriculture robots
- Lab automation
- Multi-axis systems
- Medical equipment
- Special machinery

TELEREX B.V.

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TEVEL

A passion for mechatronics

With a no-nonsense mentality and a team of 20 passionate engineers and product specialists, TEVEL is the right partner for components, technical advise, engineering, installation and support. The context of the problem always determines our advise. We first want to understand the overall challenge of our partner before suggesting a motion control solution.

Specialties

- advising & supplying components
- implementing motion control & positioning solutions
- developing & modifying operating systems
- original module manufacturer (OMM)
- installing & commissioning

TEVEL

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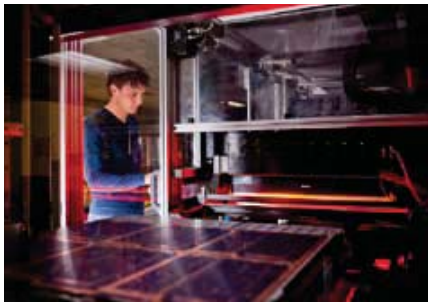
TMC GROUP

An Employeneur must have what it takes. And what it takes is not only professional skills, but guts, passion and vision as well. Our model has great appeal to people who have all this. They consciously go in search of the (market) confrontation between their knowledge and your needs.

This is what you may expect from TMC Employeneurship:

- Project continuation, as TMC has provided the missing technical competencies.
- Stability in your relationship with the hired professionals and their employer, both of them your partner.
- Employeneuring technical professionals who inject your project with new knowledge and skills. Plus the opportunity to tap into the knowledge of over 500 other Employeneurs in the TMC TechTank.
- Fast and flexible adjustment of 'technical competencies'.



TMC's Employeneurs are technically educated specialists who combine the security of permanent employment with the opportunities that entrepreneurship has to offer them. They create added value for themselves and for the company they work for, by constantly improving their knowledge and skills. They are entrepreneurs within their own job, with a sharp eye for mutual interests.

A TMC Employeneur is more than just an FTE. He will take care of your success today and tomorrow. We are proud of these people. They make us the company we are. A partner in your success.

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TNO

As an independent innovation organisation, TNO connects people and knowledge to create innovative solutions that sustainably boost the competitive strength of industry and the welfare of society. The Netherlands has a unique position in the world market for high-tech systems and equipment for next generation technology.

TNO mobilizes consortia in this innovation area by offering its multidisciplinary competencies, its domain and system knowledge to players across the entire value chain and to other knowledge institutes, including the following eight core competencies:

- System architecture: system behaviour/design, often relating to physical-transport phenomena;
- Optronics (and contamination control): precise control of photon paths in extreme environments;
- Nano-/micro-/organic electronics: precise control of small flows of electrons;
- Flowtronics: flows to precisely control intensive processes (instead of batches);
- Mechatronics (and precision engineering): precise motion control;
- Infotronics (from sensor-electronic data-flows): model-based information;
- Device architecture, especially sensors (Holst Centre, RF, nanophotonics);
- Materials: e.g. nano- or biomaterials.

The added value of TNO is anchored in our capacity to accelerate the development and introduction of new technologies based on these competencies. TNO is distinctive in its capacity to enhance paradigm shifts and make the unexpected a new reality.

TNO translates ideas or new products into processes that enable equipment manufacturers to design and deliver next generation technology. We are proud to have enabled transformations of value chains by innovation, as we did for EUV (extreme ultraviolet technology in wafer scanners of ASML), SoLayTec (ultrafast atomic layer deposition) and Holst (polymer electronics).

TNO

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TOPIC EMBEDDED SYSTEMS

Cosponsor

TOPIC Embedded Systems in Best is a high-tech technical automation company (established in 1996) specialized in embedded system development. The more than 150 enthusiastic and passionate TOPIC employees are specialized in technical software development, test, integration and configuration management and hardware design.

Our state-of-the-art projects are carried out in our office in Best and on location with our clients who are active in Semiconductor, Automotive, Healthcare and Professional Systems. We distinguish ourselves through the quality of our employees and the ease with which we do business. Our clients are generally product or system suppliers. They usually develop and produce their own products and are aware that software and hardware are becoming increasingly important components in their often multidisciplinary product. Our clients are mostly multinationals or large Dutch or Belgian players. Through many years of intensive collaboration, TOPIC has become the preferred supplier at many of these companies.

For in-house projects we have at our disposal all the necessary tools, which can be made fully compatible with your own development environment. To realize this, we use our own ISO 9001 and ISO 13485 certified quality system to guarantee the optimal quality.
As a partner to its clients, TOPIC aspires to provide the highest added value in the field of embedded systems, thereby allowing the customer to strengthen its competitive position.

TOPIC makes your project Grow!

TOPIC EMBEDDED SYSTEMS

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TRIAS

TRIAS traces external funding for companies, consisting out of grants, tax incentives or soft loans. Both national governments and the EU award huge numbers of investment grants and incentives. Innovation, R&D, export, sustainability, high-tech systems and model-driven development are examples of favourable subjects for governmental support.

There are over 5,000 schemes, so there is clearly a need for external specialists to trace the right scheme for you and ensure that you maximise the impact of external funding. The TRIAS team consists of highly trained specialists in the field of financial incentives. As independent grants consultants we can transform your ambitions, ideas and goals into projects that can receive optimum funding. Among the many available schemes, we can identify those that best match your current activities and future plans. Competition for grants is fierce, so it makes sense to make use of our skills and experience in optimising applications and meeting complex compliance criteria so that you are paid in full.

To identify your opportunities we offer you a free scan; come and see us at stand A16.

Mieke Verhaegh,
Director TRIAS BV.

TRIAS BV

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UNIVERSITY OF TWENTE

High tech, human touch. That is the University of Twente. Some 3,300 scientists and other professionals working together on cutting-edge research, innovations with real-world relevance and inspiring education for more than 9,000 students. The enterprising university encourages students to develop an entrepreneurial spirit and is a partner of Kennispark Twente.

The University of Twente participated in SmartPIE with the Robotics and Mechatronics group and Mechanical Automation and Mechatronics group. Robotics and Mechatronics (formerly Control Engineering) deals with application of modern systems and control methods to practical situations. The activities of Mechanical Automation and Mechatronics are concerned with the design and development of methods and equipment for the control and automation of mechanical systems and physical processes.

In the SmartPIE research program we concentrated on Active Damping in Precision Equipment. Specifically, the so-called rocking mode was addressed, which is a vibration mode that presents itself in machines having linear actuation, due to finite rotational stiffnesses of linear guidances. Goal of the research was to overcome the limitation that this vibration mode imposes on the machine precision and closed-loop bandwidth by means of active damping units. An active damping unit is a device that can be built into the machine at appropriate locations and that incorporates a piezo force sensor, a piezo position actuator and a controller that realizes damping. A demonstrator will be shown on the exhibition of High-Tech Systems 2013.

UNIVERSITY OF TWENTE

Robotics and Mechatronics
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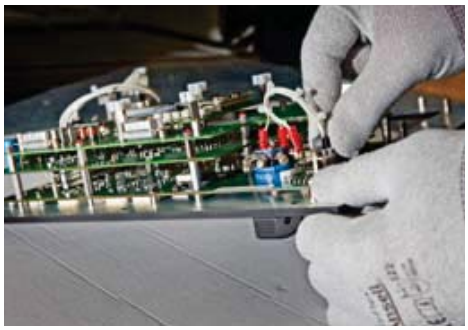
VARIASS

A system supplier with ambitions

As a system supplier and an EMS specialist, Variass provides added value by searching and finding customer-driven solutions. Our ambition is to improve our position within the Dutch and international market as a top supplier of electronic and mechatronic systems. We assume total responsibility in the area of product & process development, logistics & purchase, production & assembly, service and end-of-life management.



Variass has extensive expertise in various markets and focuses on defense, medical, water and industrial products. We develop according to the specification of the customer and therefore our principal becomes the intellectual owner of the product. To achieve this, we offer unique knowledge and experience in the field of electronics, precision components, prints and mechatronics. Quality, dependability, delivery reliability and highly adaptive capabilities translate into a solid and sustainable relationship with customers, partners and suppliers.

Our DNA: The professionalism of a large organization, the flexibility of a small company and the involvement of a family business.

Variass is ISO 9001, ISO 13485, AQAP 2120 and IPC A 610 certified.

Variass – Together we bring systems alive.

VARIASS

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VDL ENABLING TECHNOLOGIES GROUP

Platinum sponsor

As a tier-1 contract manufacturing partner, we at VDL Enabling Technologies Group believe that with support of our work the world can create breakthroughs in fighting cancer, develop new energy solutions, study space, understand the details of cells and molecules, increase the power of communication and even research where it all began with a Big Bang.

We continuously invest in our human resources, attracting the best people in the market. Enabling us to create top teams at the six production sites in Europe and Asia to develop and build cutting-edge solutions for our customers all over the world. We scout the market for new technology to create opportunities for the challenges and products of tomorrow and with our "Design to Spec" approach we stimulate our engineers to unleash the power of their creativity for our customers.

Our business offering covers the complete cycle from design and engineering, prototyping and value engineering, turn-key installation, refurbishment up to after-sales service. Our early involvement in customer projects enables us to unleash the power of our creativity. From which we are able to include elements as yield, functionality, manufacturability, reliability and cost of ownership, and exceed the customer expectations in delivering mechatronic solutions. In our development activities we actively try to reduce energy use during the lifetime of the product, and the ability of the product to be recycled (green engineering). Together with our customers we create Strength through Cooperation.

VDL ETG enables your business!

VDL ENABLING TECHNOLOGIES GROUP

VDL Enabling Technologies Group

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WEISS KLIMATECHNIK

Clean Room Technology

Weiss Klimatechnik has been synonymous with pioneering developments and high quality in air conditioning technology all around the world for many decades. Our air conditioning units and systems have proven their effectiveness wherever optimum air conditioning marginal conditions for production processes and procedures are required for both personnel and machines.

We offer system solutions and components for all clean room classes and applications to our customers, in Microelectronics, Pharmacy, Optoelectronics, Food/Beverage Industry, Medical Technology, Measuring Technology, Biotechnology or Laboratories. Weiss is one of the few operating companies worldwide that offers customised plants, air conditioning units, units and process technology from one source.

WEISS KLIMATECHNIK GMBH

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Contact: Karl-Heinz Lotz
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WIRTSCHAFTSFÖRDERUNG SACHSEN
(Saxony Economic Development Corporation)

The Saxony Economic Development Corporation (Wirtschaftsförderung Sachsen GmbH) builds bridges: For investors on their way to Saxony and for Saxony's companies on their way to the world's markets.

We initiate contact between potential investors and regions and communities in Saxony, between Saxony's companies and cooperation partners from abroad, between research and practice, between corporate ideas and economic success.

We offer

- the latest data on Saxony's economy and business environment;
- customized business site location services;
- procurement of contacts with regional decision makers;
- information on opportunities for financial support and subsidy programs;
- access to branch networks in Saxony;
- assistance in opening up new markets;
- assistance in initiating cooperative partnerships.

What can we do for you?

WIRTSCHAFTSFÖR-DERUNG SACHSEN GMBH
(Saxony Economic Development Corporation)

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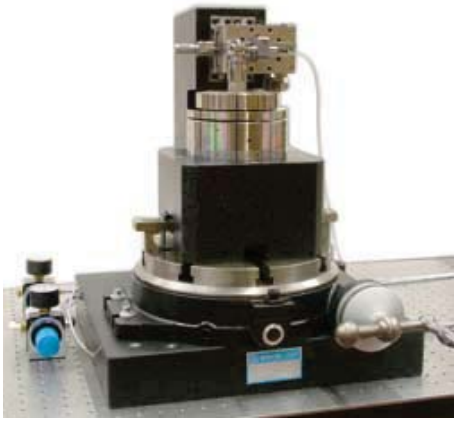
XERYON

Xeryon is a high-tech engineering company specialized in precision mechanics. As a spin-off company of the KU Leuven, we rely on more than 20 years of experience in precision engineering. Xeryon focuses on the whole engineering process: starting from the design phase, on to the production of high-precision parts, to the first prototype and the validation stage.



We designed and built several state-of-the art precision machines such as an ELID-grinder, a metrological AFM, and a nanometre-accurate spindle-analyzer. In addition, Xeryon designs customized ultra-precision piezo-drives especially for vacuum and non-magnetic applications (e.g. in electron microscopes). Xeryon provides you also small-series production capacity in precision turning, micro milling, (micro-)EDM and ELID-grinding.

Xeryon can solve all your precision mechanical problems!

XERYON

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YACHT TECHNOLOGY

Time to grow, time to Yacht

Technology is all about staying a step ahead of the competition, because success depends on the shortest possible time to market. Yacht is happy to support you with rapidly deployable specialists who can assist you in research, development, engineering and operations maintenance. This allows you to remain a flexible partner in a very dynamic market.

Expertise

Yacht is the Netherlands' market leader in providing highly educated, experienced interim professionals. We provide flexible manpower for the Netherlands' top technology companies. When you use our services you can be sure of a team with the power to implement your wishes. Our professionals have the expertise you need. They are completely familiar with all the latest technologies and have the knowledge to use them in practice.

Develop faster

When you work at Yacht, you work at an ambitious company. We will have high expectations, but we also invest in you. You will be coached and challenged to keep growing. The development of our professionals is so important, that we have our own Yacht Academy and with our knowledge meeting for our engineers, you will always be up to date and you will increase your network.

Are you the real professional we are looking for, who can make the difference at our customer? Please contact us.

YACHT TECHNOLOGY

YACHT
a Randstad company

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YASKAWA BENELUX

No. 1 in Automation

YASKAWA is the leading global manufacturer of inverter drives, servo drives, machine controllers, medium voltage inverters, linear motors, rotation servomotors and industrial robots.

YASKAWA's advanced mechatronics equipment and rich expertise in motion technology makes a real contribution to improved speed and precision in different industries worldwide. Providing solutions to our customer's machine design needs. The Yaskawa Solution Center can understand the concepts of our customers and provide a variety of optimized components for your application.

Founded in Japan in 1915, YASKAWA has been a pioneer in motion control and drive technology, launching product innovations that optimise the productivity and efficiency of both machines and systems. The YASKAWA Benelux office is located in the Science Park Eindhoven and is working in Europe with more than 1,000 people to fulfil each customer's needs and thereby increase their satisfaction.

YASKAWA products and solutions have helped to drive automation processes in many different industries such as semiconductors, advanced machine tools, automotive, packaging and textiles.

Come and meet us at booth B75.

YASKAWA BENELUX B.V.

YASKAWA

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YOKOGAWA

Since its founding in 1915, Yokogawa has grown into a multi-billion $ company and is recognised as "the world's largest maker of electronic measuring tools". Yokogawa is engaged in cutting-edge research and innovation, securing over 7,200 patents and registrations. Test & Measurement is one of the core businesses of the company. This division plays a major role in the test & measurement market worldwide with products that include oscilloscopes, power meters, optical communications test equipment, portable test instruments, recorders and data-acquisition systems.

At High-Tech Systems 2013 you will have an excellent chance to hear the latest updates from Yokogawa and get to know how we can help you to accelerate your product development by using our state-of-the-art test & measurement solutions. On the booth we will showcase how the WT1800 Power Analyser and DL850 ScopeCorder are able to offer a total overview on electromechanical systems under development. The recently introduced 8-channel Oscilloscope DLM4000 provides more detailed information about increasingly complex systems in one window. In similar applications a Yokogawa DL850 ScopeCorder is used to monitor voltage and current, serial bus data and sensor data such as temperature, vibrations and rotation.

Come and meet us at booth A21.

YOKOGAWA

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She's smart, agile and fast

www.hightechsystems.eu

Bearing and Linear Technology

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Schaeffler Group - LuK, INA and FAG - is a world wide leading company in developing, manufacturing and supplying of rolling bearings, linear systems, direct drives and maintenance products. Applications: automotive, industrial and aerospace.

Development

TNO
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TNO is an independent innovation organisation that connects people and knowledge in order to create the innovations that sustainably boost the competitiveness of industry and wellbeing of society.

member DSPE

Development and Engineering

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ACE has developed into a leading engineering and consultancy firm with a strong focus on mechanics and mechatronics. Services include conceptualization, development, engineering and prototyping.

member DSPE

Education

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