"More than mechatronics"

On 15 April, the Mechatronics Valley Twente Foundation (MVT) held its seventh TValley conference, entitled "More than mechatronics". The event in Enschede, the Netherlands, was well-attended and comprised a conference and exhibition on innovation and business for the high-tech manufacturing industry. The programme focused on exploring applications of mechatronics in various industrial and societal sectors, including robot surgery and rehabilitation as well as solar cell manufacturing and high-tech materials processing.

• *Hans van Eerden* •

The Dutch high-tech systems industry is renowned all over the world, thanks to mechatronics, the combination of disciplines such as mechanics, electronics and software. The mechatronic approach has resulted in numerous technical highlights, including ASML lithography machines, FEI electron microscopes and Philips medical scanners. However, the application range is much wider. Fertile soil can be found in the Eastern part of the Netherlands in the Twente region, so Arie Kraaijeveld, president of the Innovation Platform Twente (IPT), claimed in his opening statement of the TValley conference on 15 April in Enschede.

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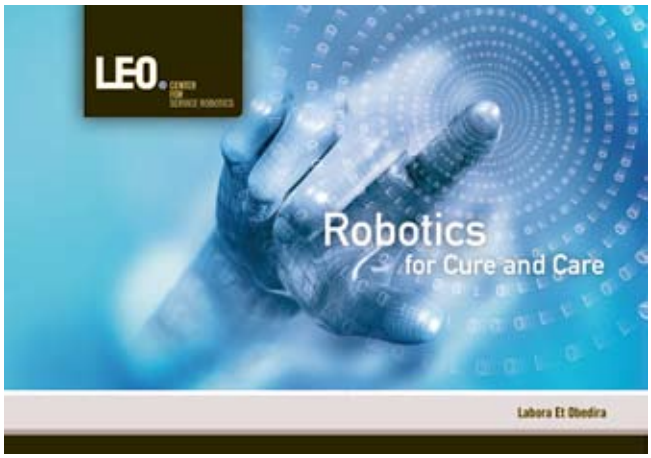
(Photos, unless otherwise stated: University of Twente)



IPT-president Arie Kraaijeveld (right) has received the first copy of the "Robotics for Cure and Care" report; on the left MIRA managing director Martijn Kuijt.

Kraaijeveld described 'his' IPT as a support system that keeps the regional 'innovation machine' running by defining new projects again and again. For example, promising projects can be found in the area of (medical) robotics. November last year, researchers and entrepreneurs from the Eastern Netherlands visited the US east coast for inspiration. Their findings were published in the "Robotics for Cure and Care" report. Arie Kraaijeveld was handed over the first copy by Martijn Kuijt, managing director of MIRA, the biomedical technology and technical medicine research institute at the University of Twente.

Surgical robotics

This kick-off nicely introduced the first three presentations, on robotics for surgical and rehabilitation applications. Chairman of the day Herman Soemers, senior mechatronics consultant at Philips Applied Technologies and professor at the University of Twente in the MVT-financed chair of Mechatronic Design, announced as the first speaker Ivo Broeders, professor of Minimally-invasive Surgery and Robotics at the University of Twente, and surgeon in the Meander Medical Centre in Amersfoort, the Netherlands. Robot-assisted surgery has been more than science fiction for a long time already, Broeders stated. Mechatronic solutions provide the accuracy, safety and ease of use that are required for 'keyhole surgery'. Advantages for the patient of this kind of surgery as compared to conventional (large incision) surgery include less pain, better recovery and less scar ruptures. Worldwide, over 1,400 pieces of the well-known Da Vinci surgical robot have already been installed; they are being applied successfully for urological and other procedures.

The latest challenge, according to Broeders, is NOTES, Natural Orifice Translumenal Endoscopic Surgery, that is surgery via natural orifices using a flexible endoscope. At the University of Twente, technical medicine research is devoted to low-complexity, high-volume NOTES procedures, such as the removal of polyps from the gut. With that application in mind, an intuitive control, a kind of 'cockpit', is being developed for a surgical tele-manipulation system based on the flexible endoscope.

Rehabilitation robotics

In the area of rehabilitation, robots also are on the rise, for gait training of patients recovering from, for instance, a stroke. On this subject, Twente has hit the spotlights with gait training robot LOPES, that was developed by the University of Twente (MIRA research institute) in collaboration with Roessingh Research & Development, part of the Enschede-based Roessingh rehabilitation centre. Here, the added value of mechatronics lies in patient safety and smart control engineering that allows the patient to do as much active training as possible.

At the TValley event, university researcher Herman van der Kooij discussed the biomechatronics discipline, which views a human being as a mechatronic system, the aim being twofold: learn to understand human locomotion, and provide support in locomotory training. Next, Van der

Kooij addressed the nature of this support, either position-controlled (the patient being passive) or force-controlled (active patient). On this second approach the design of LOPES (Lower extremity Powered ExoSkeleton) was based, according to the 'assistance as needed' principle: the patient himself is moving and the gait training robot only provides the required additional support as determined by a smart algorithm. The effectiveness of this approach has already been demonstrated, but yet has to be substantiated by clinical evaluation.

Therefore, Rik Kruidhof, business developer at MVT member DEMCON, discussed the next phase, the development of LOPES into a commercial product that can be used in the clinic for validation of robotic gait training therapy. This broad application in clinical research requires LOPES to be highly accessible in its use, with simple controls and interfaces, and results that are made available in a simple and quick manner. Kruidhof also addressed marketing: "LOPES is not a robot, but a new way of rehabilitation. The added value when compared to current therapy lies in better reproducibility." In this way, LOPES may become a fine example of high-tech research leading to a clinically relevant product.

A test person using the gait rehabilitation robot LOPES. (Photos: RRD)

Impression of TValley 2010.

Multi-agent control

Theo de Vries, director of MVT member Imotec and associate professor of intelligent control and mechatronics at the University of Twente, devoted his presentation to modern machine control. His thesis was that in years past progress mainly was achieved in the area of hardware, where controller design more or less has become a matter of 'plug & play', that is configuring a number of standard modules. Whereas with software, design still is a case of 'program & pray'. There has been some standardisation, using function block libraries, but a lot goes wrong in programming, especially in the conditional realm ("if… then…else"). Moreover, the testing is very time-consuming and a lot of software is not re-usable.

The solution according to De Vries lies in multi-agent control: the control of a system is compiled from a number of agents that each perform a specific task (in parallel). This approach yields less code, with less complexity (and hence less errors) and more potential for re-use. The use of agents (or modules) instead of function blocks, De Vries claimed, may turn design on the software level into configuration as well. It may even add new momentum to high-tech machine building in the (Eastern) Netherlands.

Inkjet printing

A high-tech mechatronic application area on the rise can be found in (inkjet) printing. Twente Fluid Physics professor Detlef Lohse, who last year was named Simon Stevin Master, the highest degree in technical-scientific research in the Netherlands, addressed the hydrodynamics of the printing process. Here, the biggest challenge is in the formation of air bubbles in the print head. These bubbles can grow to such a size that they disturb the ejection of ink droplets. Lohse showed results of high-speed video

investigations on the origin of the bubbles. Also, his research group had developed an ingenious, piezo-acoustic method for determining bubble dimensions.

Collaboration

An example of Mechatronics Valley Twente collaboration was presented by MVT members Masévon Technology and DEMCON. Commisioned by OTB Engineering, it was concerned with the development and realisation, within a very short time span, of a sputter tool, for thin layer deposition in solar cell manufacturing. Masévon director Henk Kieft talked about the systems his company is building for Eindhoven-based OTB, a manufacturer of in-line solar cell production systems. The processes include for example PECVD (Plasma-Enhanced Chemical Vapour Deposition) for deposition of a SiN anti-reflection layer. Kieft stated that 80% of the solar systems built by Masévon end up in China.

The Masévon-DEMCON collaboration involved a tool for deposition of aluminum and vanadium contact layers, with glass acting as a carrier. The OTB commission was to deliver, within a mere twelve weeks, an R&D tool, which at a later stage could be converted into a production tool. To meet this tight deadline, the principle of concurrent engineering was put into practice: design phases were executed in parallel and compressed to the max. This required a truly multi-disciplinary team to work on a common design specification that continued to expand during the project. Therefore, it was mandatory to keep the design plan as flexible as possible, to accommodate changes on the go.

Technical challenges included the design of the large vacuum kettle in which the sputter process takes place, the vacuum loadlock (minimal pumping time) and a vacuum-compatible drive for the product carriers. Finally, the sputter tool was delivered in time. DEMCON team leader Jan Leideman concluded: “Without the close collaboration between Masévon and DEMCON, in which the fortes of both parties were employed optimally, we would not have succeeded in achieving this at such short notice.”

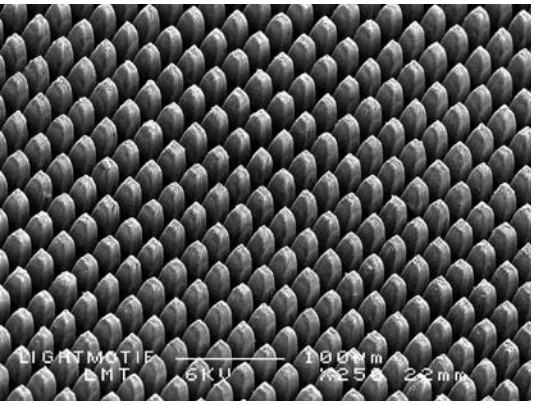
MVT Mechatronics Award

As an intermezzo in the afternoon of 15 April, the MVT Mechatronics Award was presented. This award of the Mechatronics Valley Twente Foundation for best master thesis in the area of mechatronics was presented for the fourth time. The jury was chaired by professor Herman Soemers and staffed by University of Twente mechatronics-related (associate) professors. Six master theses were judged concerning mechatronic content, quality, creativity and the student’s stimulating effect on fellow junior mechatronic engineers. The winner was Claude Lagoda from Luxembourg, who graduated with Herman van der Kooij and professor Frans van der Helm from Delft University of Technology. The subject of his master thesis was “Design of an electronic Series-Elastic Actuated Joint (eSEAJ) for the gait rehabilitation robot LOPES”.

Herman Soemers, chairman of the de MVT Mechatronics Award jury, addresses winner Claude Lagoda.

Lightmotif

Next, university spin-off Lightmotif director Max Groenendijk presented the potential of micro- and nano-manufacturing using ultrafast laser pulses (pulse lenght less than 50 ps). The advantage of these ultrafast pulses is the highly accurate machining of a metal surface without affecting the underlying bulk material, as time is lacking for the laser heat to penetrate the material. Moreover, laser machining in general benefits from being contactless (and thus having no tool wear), which further increases the attractiveness of ultrafast laser machining for various applications. For example, moulds for plastic products



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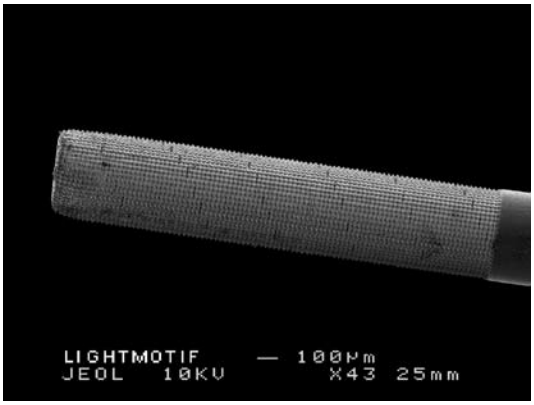

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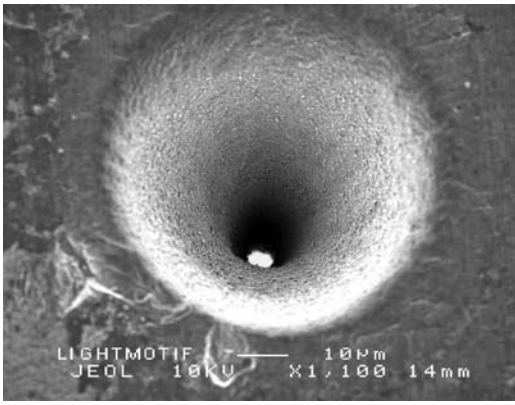

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Examples of ultrafast pulsed laser machining. (Photos: Lightmotif)
(a) Textured polymer surface.
(b) Textured needle (used for precision measurements on hydrophobic surfaces).
(c) Nozzle hole in metal foil.

manufacturing can be textured so as to make the resulting plastic surfaces hydrophobic, which can be useful for 'self-cleaning' packagings. Also, the friction properties of surfaces can be manipulated, making them for instance direction-sensitive by laser machining. And a completely different application can be found in the manufacturing of waveguides for opto-electronic components. In short, there are endless possibilities, wich is reflected by the growth of Lightmotif. It started in 2008 on the university campus, moved to the Enschede-based Business & Science Park in 2009 and will open a new laser lab and a cleanroom in the course of this year.

Warning

After all the inspiring presentations on "mechatronics and more", it was Delft professor Rob Munnig Schmidt's turn to close the conference. He seized the opportunity to express his concerns about the state of mechatronics in the Netherlands. Philips, which had been the leader in Dutch mechatronics for decades, no longer is active in this field, so Munnig Schmidt. Moreover, mechatronics as it is now being pursued in the Netherlands, is biased due to its physics orientation. "It is highly succesful, yes, but there is something missing in the area of manufacturing technology. And, is there any chance that the mechatronics industry can survive without manufacturing? No!" Software-based innovation, such as the TomTom navigator, can not be sustained, the Delft professor issued a warning.

On top of that, there is too much internal competition in "our little country". Munnig Schmidt proposed the model of one large virtual company, in which Dutch parties jointly communicate, design, manufacture and market. To conclude, he addressed the problem of 'technology pull': solving (short term) technological problems for companies is detrimental to fundamental research. "In the end, this is killing the Dutch universities of technology."

Cross-pollination

Luckily, Munnig Schmidt still found justification for a favourable outlook on Dutch mechatronics. To that end, he identified traditional Dutch strongholds, including agricultural technology and the offshore industry. "We have to exploit our market domination in 'agri' and offshore. Here, it is possible to apply knowledge from other areas (such as ASML wafer steppers). This cross-pollination has hardly been put into practice up to now." In this way, the TValley congress on "Mechatronics and more" was concluded with a call for scanning all kinds of markets on their potential for mechatronic applications.

Information

www.tvalley.nl