

Injection



The magazine from ENGEL for the plastics industry

April | 2018

Intelligent system solutions for more clarity, safety and efficiency

ENGEL presents enhanced industry expertise at the NPE2018

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Turned upside down

New cleanroom concept for high temperature applications

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Dynamically controlled multi-circuit temperature control for more transparency, quality and efficiency

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Razor-sharp knives produced with razor-sharp efficiency

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ENGEL
be the first



Dr. Stefan Engleder
CEO ENGEL Holding

Welcome to the NPE2018!

"We've got it covered" – the official NPE slogan this year applies to the global ENGEL programme as well. We are moving one step closer to the smart factory, and increasing efficiency with innovative process technologies. The plastics industry in the US is on an upswing; together with Canada and Mexico, the US is currently among the most important sales regions for ENGEL. ENGEL has consistently invested in our sales and service teams in the Americas over the years. Constantly strengthening our application technology group and our local industry know-how has equipped us for growth and your very individual challenges. We look forward to continuing to provide you, our customers in North America and the emerging markets of Central and South America, with the ENGEL quality that you have come to expect.

As a system solution provider, we ensure that even increasingly complex processes can be easily managed and that integrated production cells can be comfortably operated. At the NPE and many other events this year, we are placing this topic front and centre – and into the context of the smart factory. Because when it comes to securely managing complexity, Industry 4.0 is an important enabler. We will present numerous new products from our inject 4.0 programme to you. At the various machine exhibits, you can experience how integration, networking and an enhanced control intelligence increase the efficiency, quality and flexibility of injection moulding.

The inject 4.0 products that we are presenting for the first time in America at the NPE include iQ flow control and e-connect. Both represent milestones along the road to the smart factory. The intelligent assistance system, iQ flow control, because it connects temperature control units with the injection moulding machine using OPC UA, the future common language in the industrial Internet of Things. And our new customer portal e-connect because it makes the paths into the ENGEL world even shorter.

Finally, the fact remains: You've got to see it for yourself! – We're looking forward to welcoming you at our trade show booth and having the opportunity to personally show you how our smart products can simplify your life.

IMPRINT

Publisher: **ENGEL AUSTRIA GmbH** | Ludwig-Engel-Straße 1, A-4311 Schwertberg, www.engelglobal.com

Editorial team: Susanne Zinckgraf, ENGEL / Martin Streicher, ENGEL (responsible editor)

Layout: NEUDESIGN GmbH

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Razor-sharp knives produced with **razor-sharp efficiency**

The market for outdoor equipment is highly competitive. Demands on both quality and price are increasing. Morakniv is one of the successful players in this area. For the production of outdoor knives, this long-established Swedish company relies on process integration, automation and its partner ENGEL.

Every hour, 480 outdoor knives leave the production cell. The knife hilts and sheaths are almost the same colour as the machines on which they are being produced. "This green is the colour of the year", explains Karl-Anders Jönson, Production Engineer at Morakniv. As we learn during our visit to Mora, even knives – at least the ones for outdoor use – are subject to fashion. Mora is to Sweden what Solingen is to Germany. For more than 400 years, knives have been produced in this small town. The sound of punch presses used to be the town's heartbeat. The family business, that bears the name of the town, was founded in 1891. Within a short time, the Morakniv brand was synonymous with quality throughout the country.

Today, 130 employees produce about 85,000 knives per week, which are sold in more than 65 countries.

The royal house of Sweden is one of their customers. The product line ranges from professional knives for construction and the trades, to kitchen and woodcarving knives, to hunting and outdoor knives in various colours and designs. "Outdoor customers who buy the knives for their private use are the most demanding", says Jönson. For them, not only the quality counts. The design has to be just right, and so does the price. While many of Morakniv's competitors have their knives produced in Asia, the traditional Swedish brand relies on a high degree of in-house production expertise. From the steel blades to the plastic hilts to the sales packaging, the complete value creation takes place in Mora. Best quality at the best price – with its highly integrated production, Morakniv makes sure to keep this promise.



The multi-layered knife structure reduces cooling times during injection moulding.

Turnkey from a single source

The demands on "Gabriel" are very high: always available, consistent quality and the highest output. "Gabriel" – this is what Morakniv employees call the production cell with the green injection moulding machines by ENGEL. In order to optimally utilise all efficiency potentials from the get-go, the knife manufacturer entrusted the Austria-based injection moulding machine builder with the development and implementation of the production system. "The fact that ENGEL supplies complete system solutions from a single source was a deciding factor in our purchase decision", emphasises Johan Hed, Maintenance Manager at Morakniv. "From project planning to service for the entire system, we wanted to have a single phone number and a supplier large enough to handle this project." "Morakniv gave us a lot of freedom and included us starting with the design process", reports Lars Eric Ericson of ENGEL Sverige. "That makes this a truly exemplary project. We were able to tweak all the efficiency screws and have achieved a result that significantly increases our customer's competitiveness." In order to produce 4 knives and their sheaths every 30 seconds, ENGEL integrated three 120 tonne victory injection moulding machines, another victory machine with 180 tonnes of clamping force, three ENGEL viper 40 linear robots and a circulating conveyor system in an extremely compact area. In addition, there are a large and a small integrated multi-axis ABB robot, and units for folding the sales displays and packing the final products. The general contractor also took on the project planning for the injection moulds. The moulds were constructed by Hofmann in Lichtenfels, Germany.

Four injection moulding steps, precisely timed

The finished and sharpened knife blades are delivered to the injection moulding cell from the adjacent production hall. The larger of the two multi-axis robots takes four blades at a time from the magazine, fixes the blade tips in a carrier strip, and passes this on to the central conveyor system – this work step starts the production cycle. A viper linear robot picks up the set of blades, along with the carrier strip, and places it into



Until the hilt production is complete, the knives remain fixed on the carrier-strip in a pack of four.



The circulating conveyor system at the centre of the production cell links the three victory 120 machines that produce the knife hilts.

the mould of injection moulding machine no. 1. In the first injection moulding step, the hilt support is formed from polypropylene. The same viper that places the blades into the mould removes the pre-injected parts and transfers them into the mould of machine no. 2. After the second injection moulding step – again using polypropylene – the design of the knife-hilt is recognizable. Via the circulating conveyor system, the next stop is the third victory 120, for which the parts handling is also performed by a viper 40. In this machine partial hilt surfaces are injected using either TPE for better grip properties or another polypropylene, dependent on the model, which may have a different colour than the base body.

Finally, the viper robot removes the finished knives and places them – still fixed on the carrier strip in a 4-pack – on the conveyor system. At this point, the large multi-axis robot takes over again. It removes the knives from the carrier strip and places them into the sheaths, which were injected by the fourth injection moulding machine – the victory 180 – while the grips were being produced. The 180 tonne machine is equipped with a dedicated viper 40, which removes the sheaths from the mould and places them into a tray. Filled with the knives, the boxes are passed on to the smaller multi-axis robot. Its job is sorting the knives with their sheaths into the sales displays. Each cardboard box, with the Morakniv label, contains 15 knives – the perfect size to place next to the store cash register and increase sales.



"Gabriel" – that is what the Moravnik employees call the production cell.



The highly integrated production cell delivers 480 outdoor knives per hour.

Tri-layer structure for shorter cooling times

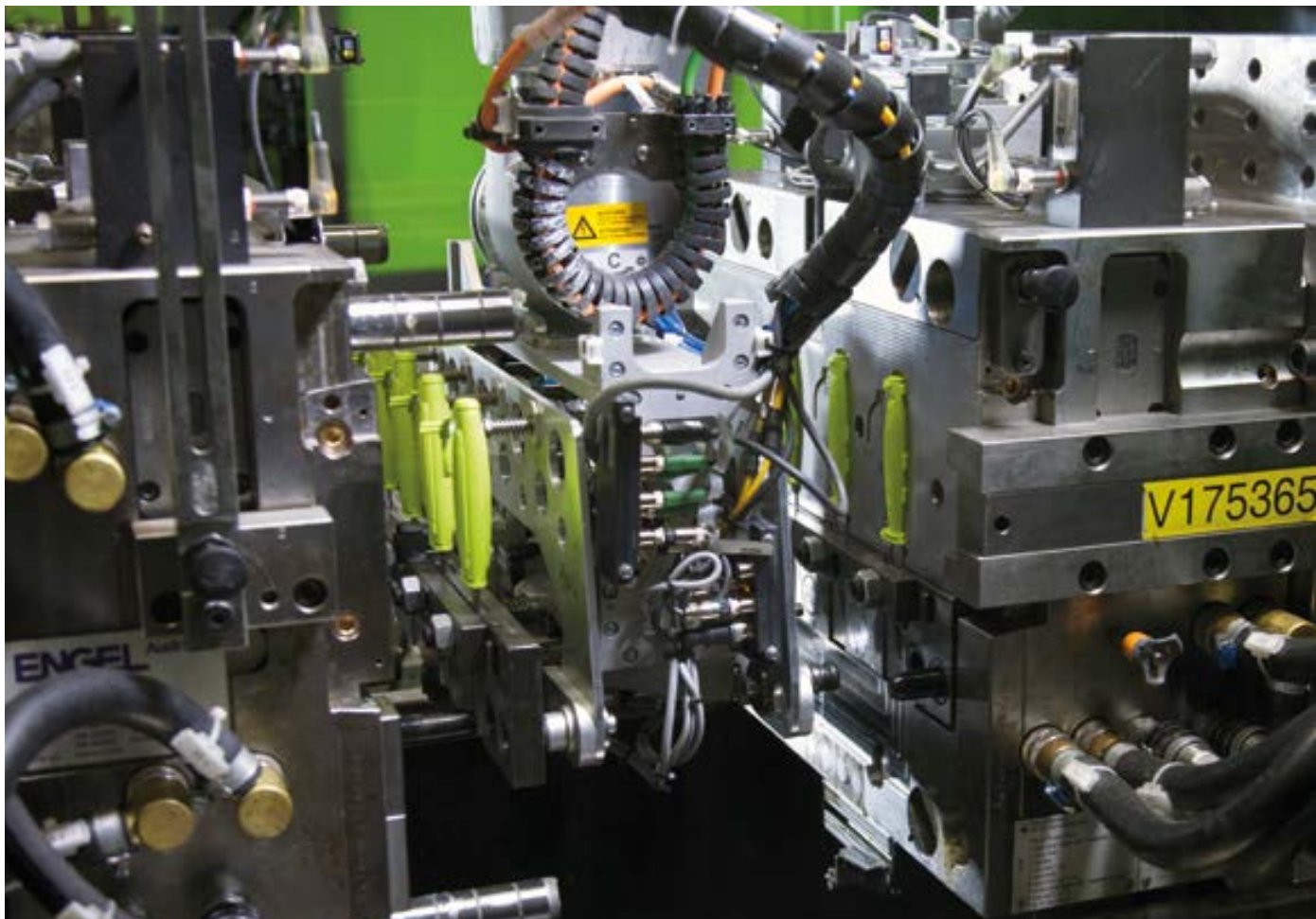
"This highly integrated process has tremendously increased our productivity, as well as our quality", summarises Jönson. "Gabriel" replaced an older production cell that was based on a different process and grip design. For a long time, the thermoplastic component of the knife hilts was injected in one step and in one piece. However, it had to be cooled in a water bath before further processing, which reduced overall efficiency. Although the previous production cell consisted of only two injection moulding machines, it only managed 180 knives per hour, a rate not even half as productive as "Gabriel". The primary key for the high performance of the production cell is the automation. Through the intelligent linking of the machines, the entire handling takes place completely in line with the injection moulding processes and requires no additional time. Also, the fact that the robots can enter the mould area of the tie-bar-less victory machines directly from the side saves valuable seconds. Secondly, the multi-layered structure of the knife hilt ensures such a high output. "Cooling times are a factor", clarifies Ulf Eriksson, Design Engineer at Morakniv. "The application engineers of ENGEL in Austria determined the structure for the shortest cooling times in tests and with calculations." One result of the extensive development work is that the support structure created in the first step is not massive, but has many ribs, allowing for

the circulation of air. "We have significantly changed our original design", says Eriksson. "ENGEL has a lot of experience in how the design affects the production process. We benefited from that."

Maximum availability

With "Gabriel", Morakniv has not only entered a higher league in terms of productivity, but the flexibility of production has also increased significantly. Thanks to the dictates of fashion, design and colour changes are very often part of the job in the outdoor sector. In addition to the many different models and colour variations that Morakniv delivers under its own label, there are also branded products – for example for home improvement chain stores. From good part to good part in less than an hour – that was the target set by Morakniv for the general contractor ENGEL. Therefore in the new solution, instead of the complete moulds, only the cores are exchanged.

Regardless of the enormous complexity of the overall process, the production cell achieves very high availability. "Especially in chained processes, this cannot be taken for granted", says Hed. "If a single machine fails, the entire cell goes down. However, since commencing operations, this has never happened. The ENGEL machines are very stable and work with a high degree of process consistency." In spite of this, Morakniv has made preparations for the worst case



In the first injection moulding step, the knife blades are overmoulded with polypropylene.

scenario and equipped the injection moulding machines with the online support and remote maintenance tool e-connect.24. Via a secure data line, the ENGEL experts can connect from Austria, find the error, and ideally fix the problem directly over the internet.

Productivity, availability – a third efficiency factor is still missing: energy consumption. All four linked victory machines work with ecodrive. The servo-hydraulic prevents energy losses and significantly reduces overall energy consumption. So "Gabriel" requires less energy than the previous system, even though more injection moulding machines are involved. "Energy is cheap in Sweden", states Jönson in regard to the relevance of this factor for the cost per unit. He hastens to add, however: "For us at Morakniv, energy efficiency is still extremely important. After all, it's about our planet." As an outdoor outfitter, Morakniv is especially committed to the environment.



*From left to right:
Lars Eric Ericson of ENGEL Sverige,
Johan Hed, Ulf Eriksson and
Karl-Anders Jönson of Morakniv and
Franz Pressl of ENGEL AUSTRIA.*

ENGEL worldwide. around the corner.

Understanding and trying out inject 4.0 Event at ENGEL Polska



With 300 participants, the inject 4.0 Symposium at ENGEL Polska in Warsaw was a resounding success. For six days, ENGEL's customers were able to experience live the opportunities that the digitalisation and networking of production processes are opening up for their own individual challenges. "The participants were impressed by how much they could achieve even with individual, smaller solutions", states Piotr Nachilo, Managing Director of ENGEL Polska. "The modular approach of ENGEL's inject 4.0 programme makes it easy to become familiar with the topic, even if you have limited experience of Industry 4.0. With inject 4.0, we are supporting our customers on their path to the smart factory." The participants had a lot of questions, which Piotr Nachilo and his team,

together with the product managers and developers from Austria, answered in detail during the lectures and, especially, at the live exhibits in the technology centre.

In addition to ENGEL's customers, students from the five largest polytechnical colleges in the country were invited to learn more about the practical aspects of Industry 4.0 in the plas-

tics industry. Traditionally, ENGEL Polska strongly supports the training of engineers.



5 years in the south-west ENGEL Germany Technology Forum Stuttgart

Five years ago, ENGEL opened its fourth sales and service subsidiary in Germany near Stuttgart, and is now, at this anniversary, looking back at a consistently successful business development. Starting with 22 employees, ENGEL has more than doubled its staff in Stuttgart. "By the end of this year, we will be 50 employees", reports Claus Wilde, Managing Director of ENGEL Germany at the Stuttgart location. "Five years ago, we set out with the goal of establishing an information and communication hub for the injection moulding industry in south-western Germany. We have achieved this goal." From the beginning, the subsidiary has regularly organized trade conferences, technology workshops and seminars. Last year alone, 900 guests participated in these events.



The order volume and sales in the region have also increased over the past five years, which Claus Wilde chiefly attributes to two factors. On the one hand, ENGEL was able to win new customers in south-western Germany. On the other hand, development of the industry in the region is particularly dynamic. Baden-Württemberg



"We have become well-established as an information and communication hub for the injection moulding industry in south-western Germany."

Claus Wilde, Managing Director of ENGEL Germany



is a European pioneer in the area of electro-mobility, which requires more and more metal/plastic composite components for its new drive concepts. With its continuous growth in personnel, ENGEL Stuttgart is addressing the growing number of orders and increasing demands. "In the coming years, we will also continue to grow in the area of service", announces Achim Würth, Head of Service at ENGEL in Stuttgart.

ENGEL presents self-optimising machine Plast Eurasia in Istanbul

"Experience the smart factory" – was the motto of ENGEL at the Plast Eurasia in Istanbul. "At our booth, visitors to the fair were able to experience and try for themselves both completely new and well as established products", says Abdulkadir Topucar, Managing Director of ENGEL Enjeksiyon Makineleri. "The processors were particularly impressed by the modular approach of our inject 4.0

programme, because it makes it so easy to benefit from the opportunities provided by digitalisation and networking." On an all-electric and tie-bar-less emotion 80 TL injection moulding machine, ENGEL produced inject 4.0 logos during the four days of the

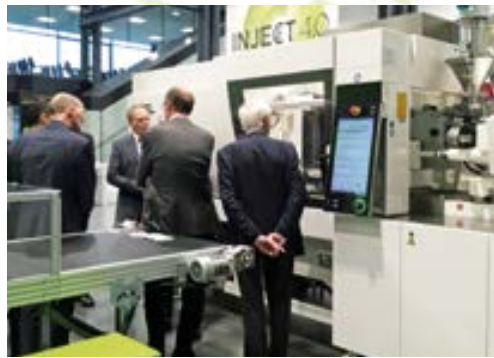
trade fair, and was able to simulate fluctuating process conditions in the CC300 control. In spite of this, thanks to the intelligent assistance systems iQ weight control and iQ clamp control, no rejects were produced.



Networking at the new subsidiary ENGEL med.con in Hannover

More than 50 medical experts discussed current and future challenges in medical technology, and exchanged their experiences, at the medical technology conference med.con at the ENGEL Germany subsidiary in Hannover. "The feedback of participants is excellent, above all because many suggestions can be immediately put into practice", reports Christopher Vitz, Managing Director of

ENGEL Germany at the Hannover location. The lectures were focused on requirements and trends, innovative products, the opportunities of digitalisation and, in particular, integrated system solutions, since the close collaboration of all companies at an early stage of the project has increasingly proved to be a success factor. A particular highlight of the med.con 2017 in Hannover was the live production of interdental brushes in a highly integrated and fully automated production cell.



Matteo Terragni is the new Managing Director ENGEL ITALY

ENGEL ITALY has begun its generational shift. On January 1, Dr. Matteo Terragni took over as Managing Director. The previous Managing Director, Maurizio Passalacqua, will remain with the company for a while to smoothly transition the business to his successor. "We are very happy to be able to organise the change with a long-term view, thus ensuring a high degree of continuity for our customers", emphasises Dr. Christoph Steger, CSO of the ENGEL Group. "With Dr. Matteo Terragni, we have gained a very experienced injection moulding expert, who has already done a lot of work with ENGEL. This facilitates a smooth transition for our customers as well as the ENGEL Italy team." In 1990, Maurizio Passalacqua became the Managing Director of the just previously established subsidiary. He has positioned ENGEL very well in the Italian plastics industry and, with great commitment, has continuously expanded the product line for processors in Italy. "He is turning over the subsidiary in excellent condition", says Steger.



"I am familiar with ENGEL as a reliable partner in terms of quality, availability and innovative technologies. That is why I am proud to now be a member of the ENGEL family."

Matteo Terragni, ENGEL ITALY

Economical injection moulding of thick-walled lenses

Chinaplas in Shanghai



"The investment climate in China is on a new high," reports Gero Willmeroth, President Sales and Service of ENGEL Machinery Shanghai, leading up to Chinaplas. Investment is being made in new technologies that help to raise production efficiency and product quality.

This is the first time that ENGEL is presenting a complex multi-

component process with interlinked injection moulding machines at Chinaplas. Two duo machines will produce LED lenses for vehicle headlights, made of PMMA, with a thickness of 22 mm. In order to combine high optical quality with highly efficient production, the ENGEL optimelt technology is used. First a preform is produced, and then further layers of the same material are added to it in subsequent stages. For cooling, the base body of the lens is removed from the mould, which further shortens the cycle time.

New apprentice workshops

Training in St. Valentin and Dietach



ENGEL is continuing to expand its apprentice training in Austria. In order to provide interested youth from the Steyr and St. Valentin regions with a local opportunity, the large machine plant in St. Valentin and the production plant for robots and automation systems in Dietach are receiving their own apprentice workshops. Training will begin this fall for additional apprentices currently being hired for both locations. The training workshop in the large machine plant will become the competence centre for the training of machining technicians. At the Dietach plant, the main focus will be on the area of mechatronics, with an emphasis on robotics and automation. The model for the two new apprentice workshops is the state certified training workshop at the company headquarters in Schwertberg. "With a retention rate of 98 percent, our in-house apprenticeship programme is a significant factor in securing a skilled workforce", says Johannes Höflinger, who is responsible for apprentice training in the Austrian plants.

LSR premiere in Sibiu expoplast in Romania



The processing of liquid silicone places especially high demands on process consistency and precision, yet must still be implemented in a highly cost-effective fashion. "This applies in particular when producing infant products or diaphragms for industrial applications", says Sergiu Sora, Managing Director of ENGEL Injectie in Bukarest. At the expoplast in Sibiu, Romania, ENGEL clearly demonstrated how, thanks to sophisticated machine technology, automation and process integration, a low cost per unit can be combined with a high degree of product quality. ENGEL produced pressure reservoir diaphragms for pressure equalisation tanks, in a two-component design, on a tie-bar-less victory injection moulding machine with integrated viper linear robot.



"For the first time, a LSR application was presented at the expoplast."

*Sergiu Sora,
ENGEL Injectie*

Efficient team with local partners

Plastics & Rubber Vietnam

The packaging industry is among the fastest growing sectors in Southeast Asia, and at the same time, one of the most important drivers of innovation. Competitive production is only possible when maximum throughput, a stable process and a high degree of process integration all come together. ENGEL demonstrated how these requirements can be implemented in practice at the Plastics & Rubber Vietnam in March in Ho Chi Minh City, with the production of oval bowls, which are typically used for ready-to-eat meals. An all-electric e-mac 440/180 injection moulding machine with integrated in-mould labelling (IML) was used. "IML makes high-quality



decoration economical and also allows for the efficient production of smaller batch sizes", says Nguyen Hieu, Manager of ENGEL VN. ENGEL completed the IML automation together with JET Engine Automation, and using a 4-cavity mould produced by CNN Plastic System; both companies are based in Taiwan. "The cooperation with Asian suppliers allows us to guarantee a high-degree of cost-effectiveness, even for the more demanding applications of our customers in Asia, and to maintain short delivery times for the overall system", states Kurt Hell, head of the Packaging and Medical business units at ENGEL in Asia.



"We have very strong partners in Asia who are also very familiar with the requirements of local processors and are translating these into optimal solutions."

Kurt Hell, ENGEL in Asia

Innovations inspire the plastics industry

Saudi PPPP in Riyadh

With innovative products and applications, the injection moulding industry in Saudi Arabia returns with new-found strength. This was clearly noticeable at the Saudi PPPP in Riyadh this January. "We are increasingly discussing new product ideas with our customers, which actively contributes to strengthening local value creation and boosting the economy", emphasises Andreas Leitner, Sales Director Middle East at ENGEL. Three sectors in particular are profiting from the upswing: the construction, logistics and packaging industries. The focus at ENGEL's trade fair booth, among other topics, was on the efficient production of electro-fusion fittings on tie-bar-less victory machines, the high energy efficiency of the all-electric e-cap series for the production of beverage caps, and on particularly sustainable plastic pallets, because the plastics and petrochemical companies have recently ramped up their efforts to completely eliminate the use of wooden pallets in the region.

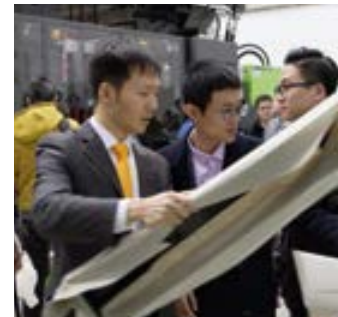


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Expectations exceeded by far

DecoJect event in China

"The interest of the automotive suppliers in China in DecoJect technology has far exceeded our expectations", says Michael Fischer, Head of Business Development



Technologies at ENGEL, about the more than 150 participants at the DecoJect Event. Together with its partners, the injection moulding machine builder put on the event in Shanghai. In addition to lectures, there was a live demonstration in the technology centre of the ENGEL large machine plant. Door claddings for passenger cars were produced on a duo machine. "Our guests were especially impressed by the high degree of integration of the production cell. The highly automated process delivers ready-to-install decorative components in a single step", states Fischer. DecoJect combines injection moulding and IMG (in-mould graining), making it possible to very cost-effectively enhance injection moulding parts both visually and functionally, and to harmonise the surfaces in the vehicle interior, even for smaller lot sizes.



"Compared to painted injection moulding components, visible components produced with DecoJect provide a significant cost benefit."

*Michael Fischer,
ENGEL AUSTRIA*

Preview

Chinaplas, Shanghai/China, April 24 - 27

NPE, Orlando/USA, May 7 - 11

Elmia Polymer, Jonköping/Sweden, May 15 - 18

Technical Fair, Belgrad/Serbia, May 21 - 25

Plastpol, Kielce/Polen, May 22 - 25

Plast, Milan/Italy, May 29 - June 1

Interplas, Bangkok/Thailand, June 20 - 23

MD&M East, New York/USA, June 12 - 14



The ENGEL lightweight construction experts: Matthias Mayr, head of the new ENGEL Composite Systems (left), and Norbert Müller, head of the Centre for Lightweight Composite Technologies.



Production processes developed in the Centre for Lightweight Composite Technologies are increasingly finding their way into practice.

New dual leadership for ENGEL lightweight technologies

With a new structure, ENGEL continues to strengthen its lightweight construction expertise and is preparing for the increasing use of innovative composite technologies in practice. ENGEL Composite Systems is the newly established sub-division, which supports ENGEL customers in the project planning and series launch of production systems for the manufacturing of fibre-reinforced plastic composite components.

Lightweight construction is one of the most important growth drivers in the plastics industry. ENGEL recognised this trend early on and established its own Centre for Lightweight Composite Technologies in 2012, at the site of the large-scale machine plant in St. Valentin, Austria. From the beginning, the goal was to intensify further development of fibre-composite technologies in cooperation with customers, partner companies and research institutes, and to enable highly efficient and economical processes for high volume series production, for example in automobile construction and consumer electronics. "In the past five years, we have achieved a great deal together with our partners", emphasises Dr Stefan Engleder, CEO of the ENGEL Group. "Some processes have outgrown the fundamental development stage and are being implemented more and more in customer projects. This trend is reflected in the new structure."

Newly established ENGEL Composite Systems

From now on, ENGEL Composite Systems will be responsible for the project planning of composite systems and project execution in all national markets. Thus, the new sub-division represents an important interface for ENGEL customers between the Centre for Lightweight Composite Technologies, the business units and the

automation division. Like the Centre for Lightweight Composite Technologies, ENGEL Composite Systems is based in St. Valentin. Matthias Mayr has taken over responsibility of the new unit.

Pushing research even more intensively

Until now, project planning for the sold composite systems has been handled in the Centre for Lightweight Composite Technologies. However, the increasing demand for integrated lightweight construction solutions requires a separation between the actual project business and the development work, states Dr Christoph Steger, CSO of the ENGEL Group: "Doing so ensures that we can continue to advance the research and development of new production processes with great intensity, while also continuing to represent a wide range of technologies." The new head of the Centre for Lightweight Composite Technologies is Dr.-Ing. Norbert Müller. Both Matthias Mayr and Norbert Müller have been a part of the ENGEL lightweight construction team for many years and are bringing a great deal of experience into their new responsibilities. Peter Egger, the previous head of the Centre for Lightweight Composite Technologies, has transferred to ENGEL application technology at the corporate headquarters in Schwertberg as Director of Advanced Technologies.

Intelligent system solutions for more **clarity, safety and efficiency**

ENGEL presents enhanced industry expertise at the NPE2018
West Hall, Booth W3303, May 7 – 11 | Orlando/Florida, USA

Highest degree of quality and cost-effectiveness – at the NPE2018, with a multitude of exciting injection moulding applications for the automotive, teletronics, technical moulding, packaging and medical industries, ENGEL will prove that this does not have to be a contradiction in terms. ENGEL relies on innovative technologies, tailor-made production concepts and intelligent controls in order to guarantee its customers a decisive advantage.



"As a system solution provider, we make sure that even complex processes can be controlled easily and safely. The exhibits at our trade show booth will clearly demonstrate this".

Mark Sankovitch, President ENGEL North America

Automotive: Premium interior components at low cost per unit

For the first time in North America, ENGEL will present a fully automated, integrated production cell for the DecoJect process at its trade show booth. Developed in collaboration with several companies, the technology combines injection moulding and IMG (in-mould graining), and makes an important contribution to the economic harmonisation of interior vehicle surfaces. All desired surface properties such as colour, pattern, structure and haptics are realised by the foil. In addition, MuCell foam injection moulding technology is used in order to save raw material during back injection. With its advanced automation expertise, ENGEL is making a significant contribution to the cost-effectiveness and flexibility of the DecoJect process. The ENGEL easix articulated robot and the laser station for the fine trimming of the foils are integrated in an easicell. Thanks to its standardised and modular structure, the automation cell developed by ENGEL allows for the integration of robots, as well as the process steps preceding and following injection moulding.

ENGEL AT ITS PARTNERS



For the manufacturing of airline cups in thin-wall technology, Campetella Robotic Center combines an ENGEL e-motion injection moulding machine with a high-speed automation and packaging unit.

South Hall, Booth S27009

At Wacker Silicones, LSR coasters are produced on a hydraulic victory machine.

South Hall, Booth S24179

At the trade show booth of the mould-builders Burteck, another tie-bar-less LSR application will run on a victory injection moulding machine.

South Hall, Booth S30045

Shin-Etsu Silicones presents the production of eyeglass lenses using optical LSR on an all-electric e-mac.

South Hall, Booth S20125



Medical: Interdental brushes in a one-shot process

With its very high degree of integration and automation, the health-care application in Orlando is equally impressive. Interdental brushes known as "scrub!" will be produced on a clean-room version of the all-electric e-motion 170/110 T injection moulding machine. Together with the grip surface and core, up to 500 bristles can be formed in a single-component injection mould. Immediately after injection moulding, the parts will be inspected by camera and packed in retail bags, 16 parts in each. A bag leaves the production



cell every four seconds. The highly integrated manufacturing process and the single-component design surpasses the efficiency of market-established products and processes many times over.

With a total shot weight of only 1.93 grammes, completely filling eight cavities with extremely delicate brushes places very high demands on the mould as well as the injection moulding machine. ENGEL has two responses to this: First of all, the all-electric high-performance e-motion injection moulding machine, and secondly the intelligent assistance systems from its inject 4.0 programme, which detect and automatically compensate for fluctuations in the environment and the raw material before they result in rejects.

Teletronics: Process integration increases competitiveness

In the teletronics industry, process integration is often related to plastic/metal composite components. At the NPE, with the production of thermal-switch housings such as those used in the monitoring of electrical automobile engines or in white goods, ENGEL will prove that it can also meet this challenge with tailor-made solutions. From punching the contacts to inspecting and labelling the ready-to-use electronic components, all the worksteps are completely automated. The raw material for the brass carrier plates is fed directly from a reel and pre-punched inline, including creating a thread. The thread is servo-electrically tapped before the carrier plates – still on the line – are overmoulded with



fibreglass filled polyamide on an insert 60V/35 single vertical injection moulding machine. The quality control also takes place in-line. Eight ready to install parts leave the production cell every 20 seconds.

The production solution, implemented by ENGEL in collaboration with its partner MMS Modular Molding Systems, guarantees the lowest possible unit costs while achieving a high degree of flexibility. The modular design of the MMS systems allows for the integration of additional processing modules as needed. Independent of the number of modules, the entire process can be visualised and controlled through the CC300 control of the insert machine, thus ensuring an especially simple operation of the overall process.

Packaging: Production efficiency at its peak

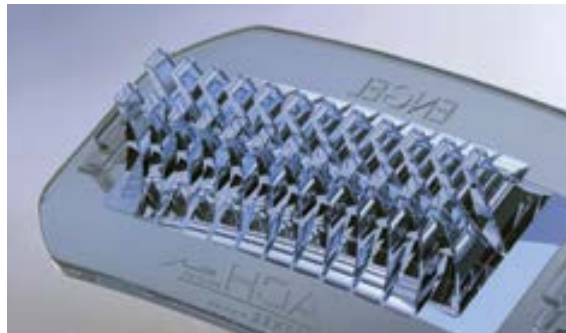
Highest degree of efficiency with the best quality and the shortest cycle times: This is the daily challenge faced by manufacturers of beverage caps. At the NPE, ENGEL presents a state-of-the-art solution for the production of 26 mm caps, including tamper-proof bands made from



HDPE. During the five days of the trade show, the production cell, based on an all-electric e-cap 2440/420 US injection moulding machine, will operate under realistic manufacturing conditions and with a cycle time of around 2 seconds, also impressing with its excellent energy efficiency and highest degree of process consistency. The machine's high-performance servo direct-drives ensure the required plasticising capacity and a maximum of usable parts even when using the new high-strength HDPE materials with a MFI significantly lower than 2 or even 1 g/10 min.

Technical Moulding: Complex liquid silicone LED lenses

Lenses for LED headlights will be produced in a dual-cavity mould on an e-victory 310/120 US injection moulding machine with integrated viper 40 linear robot. These components represent a very wide range of applications. From automotive lighting systems to building and street lighting, LSR is rapidly gaining significance in the production of high-quality LED lighting systems. This can be attributed to its particular properties. Highly transparent LSR has a lower yellowness index than conventional lens materials, is UV-resistant and remains stable across a wide temperature range. In addition, even complex lens



geometries can be efficiently and consistently produced with injection moulding. This is the first time that ENGEL is presenting the production of LSR lenses at a trade show.

e-connect customer portal launching in North America

e-connect simplifies and accelerates the communication between the processors and ENGEL, and provides a time- and location-independent overview of the machine pool, the processing status of service and support orders, and the prices and availability of spare parts. At its trade show booth, ENGEL will demonstrate how the new version of the customer portal also optimally addresses the requirements of Industry 4.0. e-connect supports all service products from ENGEL's inject 4.0 programme.



Dynamically regulated multi-circuit temperature control

With iQ flow control, ENGEL is expanding its line of intelligent peripherals. The software connects the injection moulding machine, which is equipped with the e-floMo electronic temperature control water distributor, to the temperature control units, in order to automatically adjust the speed of the pumps to actual requirements. In addition, the integrated solution allows for the active regulation of the temperature differences in all individual circuits and the automatic adjustment of the individually required flow amount for each circuit.

Together with its partner HB-Therm, ENGEL has developed its own line of temperature control units called e-temp. For networking, both companies are relying on the OPC-UA communication model, which is becoming more and more firmly established in the plastics industry and is an important component of ENGEL's inject 4.0 platform.





From left: Matthias Mayr, Walter Aumayr, Reinhard Holzner

System solutions, integration of controls and standardisation

Within five years, ENGEL's revenue on automation projects has more than doubled. The area of special automation has seen particularly dynamic growth, and this trend continues.

injection talked to Walter Aumayr, Reinhard Holzner, and Matthias Mayr to find out what is driving this growth and why the new composite procedures are demanding a great deal of automation know-how.

Walter Aumayr, Vice President of Automation and Periphery, has automation technology in his blood. He has specialized in this area since 1983, when he started with ENGEL automation technology as head of electrical engineering and drive technology. Mr Aumayr has also managed the ENGEL robot plant in Dietach for many years.

Reinhard Holzner is familiar with every detail of customers' requirements and requests. Having been with ENGEL since 2000, he gained sales and project planning experience at all three Austrian ENGEL plants, before taking on the management of project planning for the Automation and Periphery division in Schwertberg in 2014.

Matthias Mayr, lightweight construction expert to the core, is heading the newly-established ENGEL Composite Systems. Having studied plastics technology, he brought along a great deal of experience from the automotive industry and from PUR processing when he started out in ENGEL's technology centre for lightweight composites in 2013.

Automation involves more than simply placing a robot onto a machine. Why is this the case?

WALTER AUMAYR: One frequent cause is the constant progress of process integration. Automation is not only about quality, but about efficiency, which includes energy and material efficiency, as well as higher space productivity. Intelligent automation concepts are enabling completely new production processes and even completely new products, which require automation to be produced in a consistent quality. We 'tailor' automation solutions precisely to our customers' respective requirements. To achieve this, we are increasingly integrating several robots of various types and sizes into one production system, and in combination with custom-designed automation components.

What is the biggest challenge in all this?

REINHARD HOLZNER: The simplicity of the overall concept! The more worksteps we integrate and the more individual systems and/or assemblies are contained in a

production cell, the more complicated the overall process becomes. At first glance, this seems contrary to increasing efficiency. It is, therefore, our job to ensure that the overall process can be operated as easily and safely as an individual machine. The key to this is single source system solutions, control integration, and standardisation. This way, we reduce the risk of operator errors, which, with the increasing lack of skilled personnel, is becoming more and more important. Many companies are no longer able to ensure that there will be a process expert on each shift.

What exactly does ENGEL consider a system solution?

HOLZNER: In the systems business, we provide a production cell that has been precisely tailored to the customer's requirements, which, in addition to the injection moulding machine, may include robots and other automation units, process technologies, software products, tools, and peripheral units. We integrate products from our own development, as well as those from partner companies, and, nevertheless, assume the overall responsibility. That results in the customer having a central point of contact from project planning to after sales. This already helps to increase efficiency. However, what's more important is that we combine the controls of all individual systems on a central control panel – generally the CC300 control of the injection moulding machine. We guarantee uniform operating logic and common data management across all ENGEL products, which means that whoever can operate the injection moulding machine can also operate the robots and the peripherals. In particular, this makes the use of articulated robots much easier. If the machine and the robot are not from the same source, the processor generally requires specially trained, additional personnel for the programming and operation of the articulated robots.

AUMAYR: Another advantage is that for the systems solution, we coordinate all the components of the production cell with each department from the outset, allowing us to fully utilise the efficiency and quality potential. When we integrate the robots directly, we plan an extremely compact production cell from the very beginning and with consideration to all process steps and collision points. We have a great deal of experience in the coordination of the injection moulding machine with the process technology, mould, and automation. ENGEL began building its own robots and also developing tailor-made automation solutions for its customers 40 years ago.

The third key you mentioned is standardisation, but each system is unique. How does that work?

AUMAYR: Each industry has certain applications that have similar requirements. Based on our worldwide project experience, we have developed optimally coordinated concepts for these. This includes solutions for all important product groups in our five Business Units. These standards often provide a solid foundation for new

projects and strengthen the confidence that the processors place in us as their automation partner. Process integration and automation are fairly new topics for many processors, which is why they are seeking a partner from whose experience they can benefit. In addition, based on these standard concepts, we are able to quickly provide realistic system layouts and quotations – often at a fixed price – in an early stage of the project. This is often difficult for system integrators who have less experience in the various injection moulding industries.

MATTHIAS MAYR: The demand for consulting is increasing enormously. We see this quite often in the area of composite systems. Here as well, for many customers, our experience is a critical factor in their decision to work with us. Let's take organomelt, for example. The technology is still just at the cusp of large series production, but based on our international development partnerships and collaboration with institutes, we nevertheless already have standard concepts on which we can build. This provides the initial series users with a high degree of investment security.



What does the project planning for highly integrated and highly automated production cells typically look like?

HOLZNER: Optimally, we will already be involved in the project during product development, since, of course, product design is a rather significant factor in the efficiency and cost effectiveness of the production process. In the beginning, it is important to ask the right questions. We support our customers in documenting the specifications. In addition to systems technology, we are also dealing with topics such as ergonomics, workplace safety, and compliance with industry-specific laws and guidelines. In the concept phase, all of these aspects are evaluated, and the cost-effectiveness, as well as the risks, is analysed in order to design a rough concept of the production system. A detailed feasibility check is conducted before going into detailed planning. From the outset, an important aid in this is the use of three-dimensional layouts and system visualisations. When several robots and various peripheral units are interacting with each other, it is difficult to understand the process based on a two-dimensional drawing. In 3D, on the other hand, we can precisely simulate all sequences and interactions, detect interfering contours, and conduct a realistic cycle time analysis. If we are not



yet happy with the projected cycle time, we can optimise the process before even a single system component is ordered or built.

MAYR: 3D is essential, especially when using articulated robots. In composite systems, we often have multiple interactions between the articulated robots and the periphery. The goal is to produce composite components in the cycle of injection moulding processing – i.e., in under one minute. In the case of thermoplastic composite processes, we are already frequently achieving this, whereby additional work-steps, such as warming up and consolidating preforms, are also following the rhythm of the injection moulding step.



Why does automation have such a particularly important role in composite projects?

MAYR: The composite solutions developed by ENGEL are characterised by a very high degree of efficiency and cost effectiveness, which is a prerequisite for their use in large series. This is not possible without automation. The effort, or rather the investment volume for automation, including required peripherals such as IR ovens, is generally significantly higher than in pure injection moulding processes. Since one often works with fibre preforms, organic sheets, or tapes, there are many handling steps and interim stages that must be

automated. Handling and periphery must be optimally interlinked, while at the same time communicating with

the processing machine. For example, in an organomelt system that we recently delivered to a renowned Tier-1 supplier for the series production of automotive components, we integrated two articulated robots with an IR oven that is unique to the market. It is a vertical oven that can be heated from both sides and in which both halves of the oven are mounted on rigid axles in order to be able to adjust them automatically, yet flexibly.

"We make sure that a comprehensively automated system solution can be operated as easily as an individual machine"

The keyword communication is being mentioned again and again. How far is automation with respect to the topic of Industry 4.0?

HOLZNER: At ENGEL, for a long time it has been a matter of course that within a production cell everyone 'talks' to everyone, and that all possible data are exchanged with each other. In the smart factory of the future, this networking will function across the entire machine pool, and, if necessary, even across several sites. To this end, OPC UA provides us with a very high-performance and above all secure communications model, and we are confident that it will establish itself as the standard in the plastics industry. In the ENGEL system solution, machine, robot, and peripherals all access a common database, which reduces the risk of errors and, above all, increases efficiency. For example, the early start of the robot can be very easily set via a standardised entry field in the CC300 display of the machine. Furthermore, our easix articulated robots can synchronise their movements with the movements within the mould, such as those of core pulls or ejectors. ENGEL easix robots are currently the only ones on the market that do not require any additional, expensive hardware for this. Especially

in large systems, this typically results in a significant reduction of cycle times and investment costs.

MAYR: In the composite area, when it comes to the topic of Industry 4.0, we are very much benefiting from our experience with injection moulding processes. Regarding digitalisation and networking, the injection moulding industry is more advanced than the composite sector. For example, in the injection moulding world, it is a matter of course to evaluate cavity pressures and to automatically transmit the result from the machine to the dosing unit. Similar to this, in the HP-RTM standard version we are able to offer a predictive pressure cut-off because we completely control the process via the CC300 control of the v-duo machine. For the composite industry, this is still quite special. Overall, networking and the high-level evaluation of process data also provide us with great opportunities to increase process security while at the same time reducing complexity in this area.

To what extent is ENGEL affected by the increasing lack of skilled personnel, and what is your strategy to counteract this?

AUMAYR: Finding good employees and binding them to the company is becoming more and more of a challenge and is affecting us at all of our locations worldwide – including in the area of automation technology, for which we are currently seeking numerous additional employees. The in-house training at ENGEL has always been a major contributor in satisfying our demand for skilled

workers. In order to train young people for a position in automation technology from the outset, we are currently establishing our own apprentice workshop at our robot plant in Dietach (Austria). In September of this year, the first mechatronics apprentices will start their training with a focus on automation technology and robotics. Parallel to this, we have for some time been training mechatronics engineers with the same focus at our automation plant in Hagen, Germany.

ENGEL Automation Technology

Worldwide, ENGEL delivers integrated production cells with automation solutions that are precisely tailored to customers' individual requirements. The basis for this outstanding flexibility is a comprehensive line of robots and a high degree of expertise in special automation. In order to be able to also consider the specifics of individual regions, ENGEL operates five automation centres around the world: Austria, Germany, China, Korea and the US. More than 500 of the around 6,000 ENGEL employees are currently working exclusively with automation technology.



clearmelt is the only process on the market to deliver different surface structures, which are both pre-finished and scratch-resistant, in a single working step.



clearmelt on its way to series production

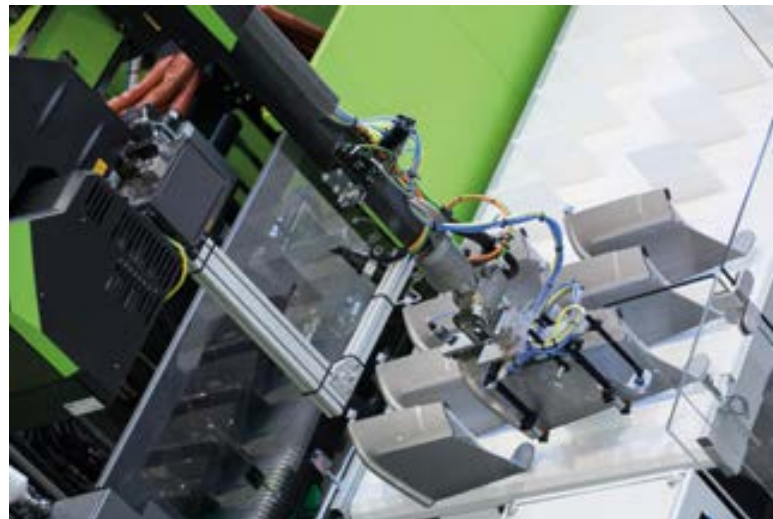
Producing high-quality yet rugged surfaces is still often a challenge for plastics processors. **clearmelt**, on the other hand, delivers ready-to-install visible components in a single working step, opening up new possibilities for the automotive industry. At the beginning, the target was on vehicle interior and electronic functional components, while recently ENGEL presented a near-serial production cell for producing exterior components.

Located in Leamington Spa, in the heart of the UK's automotive industry southeast of Birmingham, Rosti Automotive develops and manufactures a wide range of interior and exterior parts, as well as engine components, for the world's major auto makers. Process integration is essential for the supplier as a way of countering rising cost pressures and strengthening its competitiveness. As a development partner of ENGEL, Rosti Automotive is putting the latter's **clearmelt** process through its paces, testing the possibilities and evaluating its suitability for series production.

The manufacturing cell at ENGEL's booth during Fakuma 2017 in Germany provided visitors with an insight into one of its current projects. A fully-automated duo 2460/500 injection moulding machine with integrated viper linear robot produced ready-to-install D-pillars for a current SUV model. Until now, Rosti has been producing these parts conventionally in several working steps, producing the blanks by injection moulding and then painting them. The integrated **clearmelt** process also moulds the thermoplastic base carrier first. However, the surface is then immediately finished with a layer of polyurethane in a second cavity of the same mould. The polyurethane provides both a high degree of gloss and excellent scratch resistance.

Pooled Competence

The highly integrated, fully automated process is the result of close collaboration by four partner companies, each of which is an innovation leader in their respective industry. ENGEL provides expertise in both multi-component injection moulding processes and automation, while Schöfer provides toolmaking expertise for multi-component and



The clearmelt process is fully automated.

polyurethane processes. Hennecke specializes in PUR metering technology, and Votteler is a producer of raw materials.

For systems, ENGEL offers users a central contact partner for the equipment, including moulds in some cases, from configuration right through to after-sales service. In addition, ENGEL integrates the individual components of the manufacturing cell into their control system, allowing the entire process to be easily controlled via the control panel of the ENGEL injection moulding machine.

Colour Changes in Less than 15 Minutes

To further increase process consistency under real-life conditions, the duo machine can be equipped with assistance systems from ENGEL's inject 4.0 program. While iQ weight control and iQ clamp control are used for the thermoplastics processing, iQ flow control mostly benefits PUR processing. The iQ flow control software links the injection moulding machine to the temperature control unit so the speed of the pump in the temperature control unit automatically adjusts to current requirements. The result is higher energy efficiency.

Aside from high process consistency and reproducible part quality, cycle time is a critical factor to the success of series production, and progress has also been made here. Initially, curing of the polyurethane increased the entire process by up to 30 seconds, while now the time difference to production of the carrier part has been reduced to only 10 seconds.

Another milestone has been set by Hennecke with its new Colourline and Multi-Connect systems for the polyurethane process. Previously only colourless polyurethane could be processed with this high efficiency in the clearmelt process, but Hennecke has now split the isocyanate and colour processing into two systems in order to be able to process different colours in quick succession. Colour changes take only 15 minutes.

The new PUR systems developed by Votteler have proven to be extremely rugged, a fact which makes them predestined for decorative trim on the vehicle body. They have passed both the Kalahari and Florida tests for light and heat resistance, as well as the carwash and stone chipping tests, and even remain verifiably undamaged by tree resin and bird droppings. This means that the polyurethane-coated visible parts are also superior to painted parts in terms of surface finish. Moreover, clearmelt is the only process on the market to deliver different surface structures which are both pre-finished and scratch-resistant. It faithfully reproduces embossed structures, such as leather grain, whereas painting often obliterates such fine structures.

Control elements without buttons or switches

Due to the low viscosity of reactive polyurethane components, moulds which feature complex geometries and undercuts present particular challenges. Movable elements in the mould such as core pulls and slides must be sealed individually. Schöfer is constantly developing new



solutions for this purpose – most recently it developed ejector systems for PUR-coated components, and a way of sealing openings in the support structure with polyurethane. As a result, for example, backlit displays can be integrated into the part design.

In addition, combination with in-mould labelling (IML) provides great opportunities for functional integration. Control elements are produced by back-moulding capacitive foils and flooding with polyurethane. This yields fully enclosed, rugged control surfaces.

Further application areas outside the automotive industry include control panels for washing machines and other white goods, as well as medical devices. In the medical field, composite technologies based on capacitive electronics improve safety, especially since polyurethane surfaces are also highly resistant to chemical cleaning agents and disinfectants.



The Multi-Connect colour modules are designed as mobile carts.



The space-saving cleanroom module with reversed airflow fits in the frame of the injection moulding machine.

Turned **upside down**

High temperatures are undesirable in cleanrooms, however, in the injection moulding process they are unavoidable. Research on the influence of mould temperature on the laminar flow of clean air underlines the significance of this subject and at the same time lays the foundation for a completely new cleanroom concept with reversed airflow. The first industrial installations promise great potential for even higher cleanroom quality.

For the injection moulding of thermoplastics, the resin pellets are heated in the barrel until they have reached a viscous or liquid state and are then injected into the temperature-controlled mould. The temperature of the mould is a material-specific parameter with a direct influence on the process and in particular on the cycle time. The mould temperature also influences the airflow, which is relevant to the injection moulding process in cleanrooms. The hot air radiated by the mould rises and therefore moves in the opposite direction to the cleanroom airflow, which conventionally runs from top to bottom. As the temperature rises, the particulate load increases, which puts the cleanroom quality at risk. Uneven airflow in the mould area can cause particle deposits on the parts because there is not enough clean air coming in to remove the contamination.

Influence measurable at 40°C

As part of a thesis, it was investigated at which mould temperature use of a conventional filter fan unit (FFU) or laminar flow box is ineffective. The experiments took place in the cleanroom of injection moulding machine manufacturer ENGEL AUSTRIA in Schwertberg, Austria. The LMP type laminar flow modules, developed specifically

for injection moulding machines, were provided by Max Petek Reinraumtechnik (Radolfzell, Germany).

Two system conditions were used for comparative purposes: one with normal cleanroom airflow, and the other with the mould and ejector area encapsulated with an LMP. In both series of experiments, mist was added to the mould area from above to make the airflow visible for both systems. Mould heats were also held constant across both experiments.

The simple experiment established that without an additional laminar flow module, even a mould temperature of 40°C influences the flow of clean air through the mould area. This result shows how important this research work is because such a low mould temperature can be used for only a very few applications.

The LMP was used to achieve an even more constant flow from top to bottom. The air velocity was set at 0.45 m/s in accordance with the EU GMP Directive. The mist tests in this encapsulated configuration were recorded in a video. The still images clearly show that at a mould temperature of 90°C and above a constant airflow no longer prevails and turbulence occurs. The turbulence primarily occurs directly after the mould is opened; the airflow settles again after four seconds and

the flow through the mould becomes constant again. The same measurement was repeated at a mould temperature of 140°C. Here four seconds was not enough to disperse the turbulence.

In addition to temperature, the mould opening speed has an influence on the airflow. Airflows were investigated at opening speeds of 1100 mm/s and 220 mm/s. The tests showed that slow movement of the mould mounting platen causes less turbulence than very fast opening of the mould. However, when the extremes were tested, it was shown that excessively slow opening intensifies the air turbulence as the air between the mould halves heats up again during the long mould opening time. In contrast to this, extremely fast opening can stabilize the airflow so that the mould and injection moulded parts are constantly exposed to clean air. To depict these extreme speeds, mould opening times of 12 and 3 seconds were investigated. In each case, the optimal opening speed for the purposes of cleanroom reliability depends on the manufacturing process and the mould. In practice, however, the flow effects cannot always be considered adequately when it comes to setting the opening speed. The medical technology sector is also subject to strong cost pressure, and cycle time is a decisive factor in profitability.

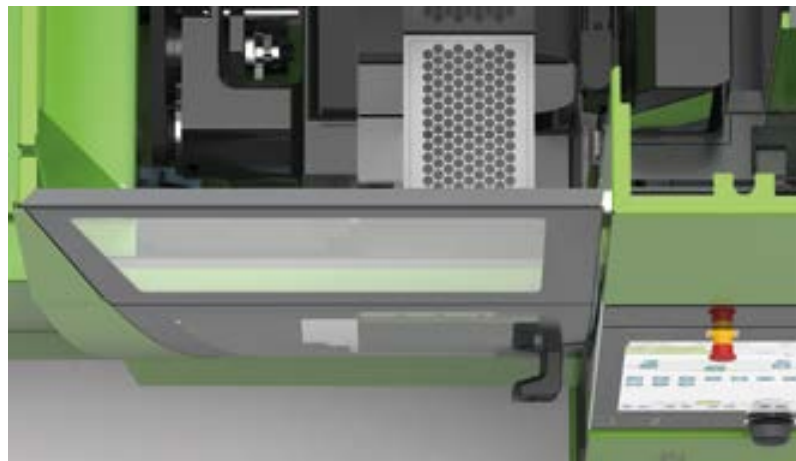
The challenge of liquid silicone rubber

The previous experiments established an important baseline for further consideration of injection moulding processes in cleanrooms. The objective of a second thesis, built on the above, was to develop approaches on how to ensure a high class of cleanroom at high mould temperatures. In order to also be able to make assertions for extreme temperature conditions, further experiments were not conducted with thermoplastics, but with LSR (liquid silicone rubber). A special aspect of liquid silicone rubber is that the material is, unlike thermoplastics, cooled in the barrel, while significantly higher temperatures of 180°C prevail in the mould. Only at these high temperatures can LSR vulcanize and crosslink. In addition to the high mould temperatures, a further complicating factor is that LSR outgasses during processing. At high temperatures silane is released, which is visible to the naked eye as a cloud. These volatile components



of liquid silicone rubber are an additional contaminate to the cleanroom and in the course of production can quickly exceed the limit defined for the respective class of cleanroom. For the experiments of the thesis, the cleanroom in the ENGEL technology center was set up as ISO Class 7. After just a few cycles, particle measurement already showed an excessively high concentration of particles.

A first approach to solving this problem was to encapsulate the mould area with an LMP in order to vaporize the silane cloud. Unlike conventional practice, however, the clean air was not introduced into the mould area from above, but from below. The downward extraction normal in cleanrooms was used to remove the silane particles. Although this experimental setup was unsuccessful, a lower concentration of particles was detected than in the previous measurement, even though it did not yet conform to the requirements of cleanroom class ISO 7.



In order to keep the particle load low even at high mould temperatures, it is advantageous to reverse the flow of clean air. A view into the mould area shows the air grille through which the cleanroom air is blown upwards.

Simulation confirms empirical research

In a second step, the idea of reversing the airflow was consistently implemented. The clean air was not only passed from bottom to top, but the mist cloud was also sucked up out of the mould area. Supported by the thermals, the mist cloud gains speed quickly and is dispersed.

A simulation of the experimental setup was used to corroborate the test results using ANSYS software version R16.2 Academic. The calculations confirm the good test results achieved in the technology center and make it possible to predict the behavior when changes occur in the environmental conditions.

Based on these results, Max Petek Reinraumtechnik has developed a cleanroom solution with reverse laminar flow whereby the air is sucked upwards out of the mould area. This solution has already been implemented industrially, and has the potential to become standard for high temperature applications.

A constant airflow no longer prevails at a mould temperature of 90°C.



Dynamically controlled multi-circuit temperature control for more **transparency, quality and efficiency**

Mould temperature control has a significant influence on product quality. This explains why Procter & Gamble Manufacturing has improved the transparency and consistency of temperature control processes using e-flomo and iQ flow control by ENGEL. This not only results in reproducible component quality, but also in significantly higher levels of efficiency.

"Temperature control was a black box for us", says Andreas Franz, process engineer at Procter & Gamble (P&G) in Marktheidenfeld, summing up the initial situation. For a long time, only the supply temperature was known. However, how the temperature is distributed over the individual heating-cooling channels during injection moulding could only be investigated using thermography, a complex process that does not give more than a snapshot. Therefore, three years ago the Moulding Technology division in Marktheidenfeld started to analyse and optimize temperature control in the injection moulding process. "Our goal was transparency, and with it increased process reliability", says Christian Rieb, Equipment Engineer at P&G. The P&G production plant in Marktheidenfeld, Germany focuses fully on oral hygiene. Electric tooth brushes for the Oral B brand are produced there for the worldwide market. As a health care company, P&G has greyroom production, all processes are validated, and quality takes top priority.

For a long time, too little attention was paid to the link between mould temperature control and product quality, but ENGEL triggered a rethink at K 2010. The electronic temperature control water manifold system, flomo, laid

the groundwork for more transparency and consistency. flomo can individually monitor and document all cooling and temperature control circuits. Furthermore, the next generation, e-flomo, is able to actively control the flow rates or the temperature difference (ΔT) in all individual circuits. The advantage is that the individually required flow rate is set automatically for each temperature control circuit. ENGEL finally took the next step, presenting iQ flow control at K 2016. The software networks the temperature control unit and the injection moulding machine to create a single unit, and controls the rotational speed of the pumps in the temperature control units on demand. "In injection moulding, around 25 percent of all scrap parts are a result of temperature control errors", explains Klaus Tänzler, temperature control product manager at ENGEL. "This is precisely why ENGEL's development team is working intensively on this topic."

Just three instead of ten temperature control units

A mould with 56 heating-cooling channels presents a particular challenge and is well suited for testing innovative temperature control technologies. This mould is for

one of the NGC charger housings for electric toothbrush handles, whose manufacturing process was the first to be investigated by the newly established Temperature Control Project Group at P&G.

The oval base of the ASA housing has a prong at the top centre that holds the electric toothbrush handle in place when charging. In the manufactured product, the housing contains all the electronics, which are safely embedded in a potting compound. "Even the tiniest dimensional deviations or incompletely injected areas cause the potting compound to leak out", explains Andreas Spitznagel, who manages the Process Technology Group for P&G in Marktheidenfeld.

In order to efficiently produce large quantities, the stack mould has a total of 32 cavities in two parting surfaces. Since the polymer melt is routed through the first parting surface to the second, a lot of heat is generated on the centre mould plate. Ten temperature control units -- eight small ones on the operator side and two large ones on the rear side of the machine -- was the status quo with the old system.

In collaboration with ENGEL, a new production cell was planned and the mould design was optimized for the use of e-floMo. All 56 connections are now arranged on one side of the mould. There are nine e-floMos near the mould, on the edge of the mould mounting platens, on the tie-bar-less victory 300 injection moulding machine. Each e-floMo supplies several temperature control circuits. From deposits in the temperature control lines to air bubbles to fluctuations in the pump performance, there are many different factors that can disrupt the temperature control process. If such an event occurs on the new systems, e-floMo detects the irregularity and automatically compensates for it. All 56 circuits are adjusted at the same time. "Reproducibility has increased enormously", reports Andres Franz. "The blindfolds have gone and we have a genuinely transparent process now."

The reliability benefits also open up massive potential savings. For example, the new production cell was originally planned with just three temperature control units -- instead of the ten used before. While three quarters of the 200 l/min flow rate available per device was initially used, it has

been possible to reduce the flow rate to 40 l/min in the course of system validation. "This is significantly less than we expected", says Rieb.



As a safety-relevant component, the housing of the NGC charger places the highest demands on dimensional stability.

Even temperature control of long finger cores

In the meantime, the temperature control expense has also been reduced in a second production cell. It also features a tie-bar-less victory 300 injection moulding machine, on which two products for the replacement toothbrush heads are manufactured: profile rings and tube sections. "Temperature control of the long finger cores forming the tube sections is critical, above all", explains Carmen Stollberger, who knows the system and all its temperature control pitfalls like no other. She joined P&G in 2015 as a student and wrote her bachelor thesis on the optimization of temperature control processes. She is now permanently employed by P&G as a process engineer. Where the system was operated with seven temperature control units plus two pressure boosting units before the project started, there are now only five temperature control units, without additional pressure boosting, for the same amount of heat.

Controlling pump speed on demand

After the great success with e-floMo, P&G is taking the next step and using iQ flow control to integrate temperature control into the machine control unit. This mainly promises two advantages. First, the software continuously adjusts the rotational speed of the pumps in the temperature control units to the demand in the on-going process, which further boosts energy efficiency. Second, integration further improves clarity.



From left-to-right: Andreas Spitznagel, Carmen Stollberger, Christian Rieb from P&G, Klaus Tänzler from ENGEL AUSTRIA, Andreas Franz from P&G, Falk Boost from ENGEL Germany, Johannes Baunach and Mario Aulbach from P&G.

Lighthouse with injection moulding machine

For Viega, getting young people fit for work means more than just imparting specialist knowledge. It's also about interdisciplinary thinking, social skills and communication skills. So that the apprentices can gain practical experience, develop creative ideas and learn even more from each other, the manufacturer of plumbing and heating installation technology has set up their own factory. At the Young Factory, commercial and industrial-technical apprentices jointly manage an injection moulding business and produce their own products on an ENGEL victory machine.

How does an injection moulding machine work? What does the quality of the injection moulded parts depend on? Why are unit costs so important? – Anyone who sees their future as a process mechanic, tool mechanic or mechatronics engineer in the plastics industry can answer these questions straight off. But are these topics of concern to a commercial apprentice? – "They most certainly are," explains Almedina Selimanjin during an editorial visit at Viega's Elspe plant. "How am I supposed to make the right decisions in the commercial organization if I don't know where the problems are in the production department?" she asks back – and that does sound logical. It's about understanding the inter-relationships and being able to assess the complexity of a globally successful, highly innovation-driven industrial

company. "That's the central theme for me," says Selimanjin. "And that's a big plus here at Viega. When I talk with apprentices at the vocational school I discover that this is not self-evident."

Almedina Selimanjin is training to be an industrial clerk and started her third year of apprenticeship in August. She is one of the apprentices who is actively involved in setting up the Young Factory project, developing new work processes, planning the training content and representing the concept externally. The apprentices are in charge of the Young Factory from the start-up phase, and say only the impetus to break new ground in training came from the management. "Our goal is for our apprentices to learn to take responsibility early on, work independently and to support each other in



*Self-designed, constructed and produced:
The apprentices use the breakfast boxes at job
fairs and information days to advertise for training
at Viega.*



"The Young Factory is a big plus in the training at Viega", says apprentice Almedina Selimanjin, here together with Volker Dresbach from ENGEL Germany and the two Viega training managers Ulrich Schmidt and Andreas Brinker (from left to right, picture).

interdisciplinary teams," says Ulrich Schmidt, the industrial and technical training manager at Viega. "That's the reason we decided, together with the management of Viega, to set up a small company for our apprentices within the larger company. A production company that is subject to real-world requirements, but which offers a protected environment where mistakes can be made, allowing the apprentices to learn from their own experiences."

Apprentices develop and produce their own giveaway

Viega is currently training 200 young men and women in twelve technical and seven commercial professions. Regardless of the profession, four weeks at the Young Factory are part of the training program in the second year of apprenticeship. Tasks include booking orders, scheduling machine utilisation and calculating the products, procuring material, setting up the injection moulding machine, injection-moulding the components and delivering them on time. At the Young Factory, executives are apprentices with only one additional year of teaching experience ahead of their "employees".

Almedina Selimanjin also handled the ENGEL injection moulding machine at the Young Factory. She did not feel any inhibitions about intervening in the process control itself. "There's always a technical apprentice there to help you. We can rely on each other and learn from each other."

The main product of the Young Factory is a breakfast box, the giveaway, which the apprentices use to advertise Viega's training at job fairs and information days. When we tell the pupils that we - the apprentices! - designed, constructed and produced this box ourselves, they are suddenly very interested in training at our company." "We have created a lighthouse project with the Young Factory," emphasizes Andreas Brinker, maintenance manager and

instructor at Viega. "We have many regional companies here that provide training, and at the same time we have a declining number of students. The competition for talent is getting tougher. That's why we as a company must be even more active to ensure we have a next generation of skilled workers. We want every student to apply for a job with us first. Naturally, we need to have a lot to offer them."

Tie-bar-less technology simplifies leap into professional life

2000 of the self-developed giveaways are produced in the Young Factory each year. The victory machine is utilized to capacity with so-called C-parts, injection moulded articles from the Viega range that are not time-critical, such as stoppers or connection pieces. "We made sure to cover a wide range of parts so that the apprentices have to set up frequently," says Schmidt. Mould change also needs to be learned. The tie-bar-less clamping unit of the victory machine optimally supports the set-up process and prepares the technical apprentices for their future jobs. The large Viega factory also produces on tie-bar-less machines.

"Only an ENGEL machine was considered eligible for the Young Factory," emphasizes training manager Schmidt. And this was not just about the simple transfer of learned knowledge to the production environment, but also about the positive experiences Viega has had in its many years of cooperation with ENGEL. "To be able to support Viega with a machine for its Young Factory project is a great honour for us," says Volker Dresbach, sales engineer at ENGEL Germany in the Hagen subsidiary. "After all, ENGEL also attaches great importance to the training of young people." And not just at its headquarters in Austria. The Hagen location, with its sales and service subsidiary and production plant for automation systems, is also a training facility.

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