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Over 3,200 exhibitors will be presenting their latest developments in the plastics and rubber sector at K. Our trade fair motto makes it clear why you can benefit from your visit to our ENGEL stand:

Experience. Passion. Innovation. – Three strong words that reflect the diversity of our industry: Regardless of your situation, you are in good hands with ENGEL.

Experience.
We are experienced technical pioneers who also uphold tradition. Tie-bar-less technology makes this evident: a controversial idea when first introduced, tie-bar-less machines have consistently increased your productivity for 30 years. At K, we will celebrate this anniversary with you and also take the opportunity to present the latest enhancements at our booth.

Passion.
Topics to which we are committed are given top priority throughout the entire ENGEL organization. For example, we translate sustainability – one of the cornerstones of our corporate culture – into tangible, forward-looking solutions for the Circular Economy. Five exhibits at three different locations throughout the show will show you how your production can actively contribute to closing the recycling loop.

Innovation.
Our vision is to shape the fusion of production processes with the digital world. Discover our practical inject 4.0 solutions in the Experience Zone that include everything known as Big Data or Artificial Intelligence (AI). Let us assist you in your progress towards the smart factory.

We look forward to seeing you at the ENGEL booth and showing you our commitment to – Experience. Passion. Innovation.
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Improved setpoint calculation of the injection speed profile
For ENGEL, environmental responsibility is a matter of focus over each family generation. Sustainability has always been an important development driver at ENGEL. In this Techtalk, Dr. Stefan Engleder, CEO of the ENGEL Group, and Günther Klammer, Division Manager Plasticising Systems and expert on the Circular Economy topic at ENGEL, talk about the new challenges posed by recycling and how ENGEL actively contributes to closing material cycles.

One of the challenges is that the image of plastics is not exactly the best right now. How do you deal with this as a plastics machine manufacturer?

STEFAN ENGLEDER: We really are at a turning point. So far, we have concentrated on making the manufacture of plastic products increasingly energy- and resource-efficient. We have dealt with the issue of recycling plastics, but – as we can see today – not consistently enough. We have to change that, and we have to do it quickly. Also, because we cannot afford to lose good specialists to other industries. The current image of plastics is a
challenge, but at the same time an opportunity. Because it is we who develop the solutions for the future.

What answer do you give to people who are consciously attempting to switch to other materials?

STEFAN ENGLEDER: We want to encourage people to take a look at the topic from a different point of view. A future without plastics cannot and will not exist. Some of the challenges of our age can only be solved with the help of plastics. Sustainable mobility, for example, would be inconceivable without plastics-based lightweight materials, and in medical technology, too, we owe a large part of the continuous progress to polymer materials. In the packaging sector, which is particularly subject to criticism, switching to other materials often leads to a worse CO₂ footprint. Our message is that plastics are very efficient and therefore indispensable materials. However, it is important that we handle these materials responsibly and ensure that plastic products do not end up in the environment at the end of their useful life, because this is an enormous waste of valuable raw materials. Now, we are all called upon – in industry, waste management and the consumers, too – to do even more.

What role does plastics processing machine manufacturing play in this?

STEFAN ENGLEDER: We use our knowledge and experience to create the conditions to return plastic products to the material cycle at the end of their useful life. Establishing a Circular Economy means that our customers have to deal with new requirements and legal requirements. We are investing heavily in research and development in this area and are therefore in a position

» We use our knowledge and experience to ensure that people in all regions of the world can handle plastics responsibly.

Dr. Stefan Engleder, CEO ENGEL Holding
to advise and support our customers on meeting the new obligations in the best possible way.

What can you do for your customers today in concrete terms?  
GÜNTHER KLAMMER: Our activities are focused on three topics: process stability, the use of recycled materials and design for recycling. In order to get the Circular Economy in the plastics industry up and running, we primarily need to increase recycling capacities, and we must have sufficient applications for recycled materials. By further improving process stability, we can use recycled materials, whose material properties naturally vary more than those of virgin materials, more widely and for higher-value applications. Industry 4.0 is an important tool for this. Intelligent assistance, an essential feature of the smart factory, makes it possible to compensate for such material fluctuations shot by shot in the on-going process. In addition, the individual components of our injection moulding machines, such as the plasticising screws, need to be geared even more specifically to processing recycling materials, shortening the value-added process. At the end of the day, processing recycled materials also has to be economically attractive in order to become more widespread.

Can you give us an example of this?  
GÜNTHER KLAMMER: One of the things we are working on is that, in addition to recycled pellets, we can also process a higher proportion of ground material directly in the injection moulding machine. To allow this to happen, the screw geometries must be adapted as do the materials of the plasticising components. There are some promising approaches for this.

But what exactly does design for recycling mean?  
GÜNTHER KLAMMER: Design for recycling is about how product developers are already looking at the way in which products can be returned to the cycle at the end of their useful life. There are approaches, for example, in the packaging industry, but also in composite lightweight design, and both areas are moving in the direction of mono-material systems. In IML packaging, for example, we can see a trend towards the packaging body and the label being made of the same material in order to enable grade purity in recycling. In lightweight design, this trend is demonstrated in the growing demand for end-to-end thermoplastic composite solutions that facilitate component recycling.

Is the Circular Economy developing into an innovation driver?  
STEFAN ENGLEDER: Circular Economy is already a strong driver of innovation, and I see a great opportunity to further expand our technological leadership as pioneers. Austria and Germany were among the first countries to set up collection systems for plastic waste and corresponding recycling capacities. With our experience, we can support other countries on this path. But we must not forget that we still have a lot to do in Central Europe. Circular Economy is a worldwide challenge with different regional focuses.

Where do we need to do more in Europe?  
GÜNTHER KLAMMER: In order to increase recycling capacities, we not only need new applications for recycled materials, but also even better collection systems in the long term. Simply putting all your plastic
waste in the yellow bin bag, although there is no common understanding of what belongs in there and what doesn’t, is not good enough. The regulations differ between communities. So far, plastics that cannot be recycled together due to their chemical and physical properties have been put together in yellow bin bags. In Europe, we could motivate the population to make sensible distinctions by providing information and education, and by means of clear and more obvious labelling on the packaging. Similarly, you could control reuse in a meaningful way through separate collection. In combination with design for recycling and even better sorting quality, the processing of plastic waste into high-quality new plastic products would become simpler and even more efficient. This would allow the EU’s targets to be achievable.

Closing material cycles requires even closer cooperation between companies along the value chain. How can this process be driven forward?

GÜNTHER KLAMMER: Even stronger interdisciplinary cooperation is essential, especially when it comes to such overarching all-encompassing challenges as design for recycling. Industry 4.0 is again helping us here. The digital transformation in which we find ourselves is leading to the establishment of horizontal platforms that empower us to optimise processes from raw material production to recycling across all functions along the entire value chain. This makes interdisciplinary cooperation even easier, which in turn gives the circular-flow economy a further boost.

STEFAN ENGLER: Circular Economy can only work if we all pull together, if we unite even more as an industry and if we succeed in taking consumers with us. Encouraged by this conviction, we signed the Ellen MacArthur Foundation’s Global Commitment to the New Plastics Economy. The initiative networks the global players and gives more voice to our common concern.

The Ellen MacArthur Foundation, founded in 2010 by British sailor Ellen MacArthur, is one of the world’s leading drivers of the Circular Economy. With its New Plastics Economy Initiative, the organisation addresses the topic of plastic packaging. The aim is to avoid unnecessary packaging and to ensure that all plastic packaging is reused, recycled or composted by 2025. Together with more than 350 other companies, universities and organisations, ENGEL has committed to making an active contribution to this goal.

To achieve this, ENGEL focuses on four topics:

- Guaranteeing high process consistency and preventing rejects, with the help of intelligent assistance systems, even if the raw material is subject to high fluctuations.
- Further increasing the proportion of recycled material in sandwich components with the help of innovative processing technologies.
- Keeping in close contact with the processors, as early as the product development phase, with the aim of reducing material use and allowing products to be recycled.
- Enhancing consulting services in the field of upstream processes in order to optimise the processing of recycled materials for injection moulding.
K 2019: ENGEL to present innovative solutions for the Circular Economy

Circular Economy is a focus at K 2019 and also the ever-present "green thread" running through ENGEL's trade fair presentation. ENGEL's contribution as injection moulding machine manufacturer and system solutions provider will be demonstrated in Düsseldorf by five exhibits at three locations. The focus is on the processing of recycled materials, the increase of process stability and the trend towards design for recycling.

Greater process stability paves way for wider use of recycled materials
The stability of the injection moulding processes is key to being able to use recycled materials also for higher quality products, as recycled material is naturally subject to greater batch variations than virgin material. ENGEL solves this challenge with the help of intelligent assistance. iQ weight control individually adjusts the quality-related process parameters for each shot during injection to suit the prevailing conditions. This reliably compensates fluctuations in the raw material as well as in the ambient conditions. The result is 100 percent good parts.

In the processing of virgin material, iQ weight control has become very quickly established. The fact that the software also works reliably with recycled material was verified by ENGEL together with the recycling specialist Erema in extensive test series. Intelligent assistance opens the door for recycled materials to a far broader range of applications.

Increasing the proportion of recycled materials in sandwich components
One further approach to using recycled materials more widely is sandwich components with a core of recycled material embedded in virgin material. The aim is, on the one hand, to design more products for this type of two-component application, and on the other, to increase the proportion of recycled material in the sandwich structures. The proportion of recycled material that can be used in the core is essentially determined by the
Considering recycling as early as in product development

Designing for recycling means that the recycling process is taken into account as early as in the development of a new product. The requirements of the circular economy and sustainability are considered in the product design. Lightweight composite design is an example where this is already working well; thermoplastic-based solutions are pointing the way to the circular economy. At its stand, ENGEL is demonstrating a challenging automotive application using the production-ready organomelt process (Page 18).

A second life for fishing nets

At K 2019, ENGEL is showing the circular economy also beyond its main stand. In the outdoor exhibition area between Halls 10 and 16, post-consumer waste is being converted into miniature waste containers on an ENGEL victory injection moulding machine. Erema’s recycling pavilion is located in the immediate vicinity, exhibiting another victory machine producing card boxes from recycled fishing nets. The polyamide recycled material comes from Chile, where three American machine manufacturers have set up collection points for used nets. Previously, these nets were often disposed of in the sea due to the lack of collection infrastructure. In Chile, the nets are recycled and processed into skateboards and sun glasses on ENGEL injection moulding machines. The project proves how interdisciplinary and international co-operation can help closing material cycles where there are no established collection systems.

Due to their shape, the transport boxes are a challenging test for the sandwich injection moulding process. ENGEL nonetheless achieves a high level of recycled content: over 50%.

geometry of the moulded part and the flow pattern in the cavity. The transport boxes that ENGEL is producing at its stand pose a particular challenge in this respect. But despite the complex component geometry, ENGEL succeeds in achieving a very high level of recycled content of over 50% with the skinmelt process. The grade purity is also important to ensure that the sandwich-moulded products can be easily recycled at the end of their service life. ENGEL is exclusively using polypropylene for the manufacture of the transport boxes; the recycled material here originates from post-consumer collection. ENGEL collaborates with “Der Grüne Punkt”, Duales System Deutschland (DSD, Germany), to this end.

Unlike classic co-injection, the skinmelt process involves combining the two melts prior to injection. The skin – the virgin material – is first to reach the cavity. It is pushed forward by the inflowing recycled PP and pressed against the cavity walls, while the core is filled with recycled material.

ENGEL has engineered an extremely compact production solution based on a duo two-platen injection moulding machine. On the duo 3660H/1560W/450 combi exhibited at K, the second plasticising unit for the skin material is located at a sharp angle above the horizontal injection unit for the recycled material – a highly space-saving design. Other stand-out features of the ENGEL solution are its easy-to-use visual display and the animation of the entire process on the injection moulding machine’s CC300 control unit. As a result, it is extremely easy to set the mixing ratio to achieve the ideal recycled content level.

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Acknowledged as best supplier
Supplier Platinum Award from Kongsberg Automotive

Global automotive supplier Kongsberg Automotive has presented the Supplier Platinum Award for outstanding performance to ENGEL. Through its Supplier Award Programme, Kongsberg Automotive gives recognition to suppliers whose performance is consistently excellent in terms of quality, service and technical support, which in turn helps to strengthen the company’s international competitiveness. ENGEL won the award in the Overall Customer Satisfaction category, with the jury’s official explanation stating that “ENGEL’s machinery and solutions make it possible for Kongsberg Automotive to manufacture products with the highest levels of process stability and efficiency. ENGEL is always one step ahead when it comes to innovative and smart technologies.” For many years, ENGEL has supplied Kongsberg Automotive plants around the world with injection moulding machines and integrated systems solutions, while helping its customer to work towards achieving a smart factory.

“We continue to invest heavily in new tools and have strengthened our service team so that we can optimally support our customers in their new challenges.”
Uwe-Christian Oestreich, ENGEL Hannover

State-of-the-art as early as the training phase
Students visit ENGEL ITALIA

ENGEL ITALIA opened up its machine technology centre at Vimercate in northern Italy for a three-day student programme. 40 students from the ITS (Istituto Tecnico

Shedding light on the legal jungle
Service Day at ENGEL Hannover

ENGEL held an all-day meeting in Hannover/Germany with the specific focus on service. In addition to lectures and live demonstrations, there was plenty of opportunity to exchange experiences and discuss individual challenges in one-on-one discussions. One focus was on the new opportunities and possibilities that industry 4.0 opens up for higher machine availability. “We can plan maintenance downtime when it best fits into the plant production schedule and, in unexpected events, use online support in many cases to ensure a stable process again within the shortest possible time,” explains Uwe-Christian Oestreich, Service Manager at the ENGEL Deutschland Hannover location. “Service is becoming increasingly important as a competitive factor.” During Service Day, ENGEL made new and proven service products accessible through examples at the numerous Expert Corners. A special keynote was given by Gehrke Econ Rechtsanwaltsgesellschaft (lawyers). The everyday life of an injection moulder is also determined by many, sometimes very complex legal obligations. The lecture “Maintenance – Liability and Risk Management” tackled the topic of the legal jungle, and on specific issues observed in injection moulding operations. “The maintenance of injection moulding machines and robots is a legal requirement,” said Oestreich.

Matteo Terragni (left), CEO of ENGEL ITALIA, welcomed the students at the subsidiary’s technology centre.

ENGFEL worldwide. around the corner.
Superiore) in San Paolo d’Argon were able to apply their theoretical knowledge on an ENGEL victory 120 injection moulding machine with an integrated viper 6 robot. The students changed the process parameters in order to investigate their influence on the component weight and surface quality. They learned from the ENGEL experts how even higher component quality, production efficiency and machine availability can be achieved with the aid of innovative industry 4.0 technologies in injection moulding. Some students already had injection moulding experience. In total, the training at the ITS includes 400 practical hours in cooperation with industrial companies.

inject 4.0 hands-on for testing ENGEL forum in Prague

After the great success of the first forum event in autumn last year, ENGEL CZ again invited its customers to its subsidiary in Prague in the early summer. The central theme of the event was inject 4.0. Processors from the automotive, technical moulding and medical technology industries discovered the opportunities opened up by digitalisation and connectivity and how these can be easily used. In addition to lectures, there were workshops and live demonstrations, and plenty of time for discussions between the attendees. ENGEL again received very positive feedback from its customers. ENGEL CZ will be continuing the forum series.

Automotive supplier Teknia is the 1000th user ENGEL e-connect customer portal

ENGEL celebrates the 1000th user of its new e-connect customer portal. At the Nivnice plant in the southeast of the Czech Republic, automotive supplier Teknia produces a wide range of products from technical parts to sophisticated visual components. e-connect supports local maintenance staff and machine operators by providing machine documentation and the ability to order spare parts from ENGEL. “The extensive machine documentation possibilities and simplified procurement of spare parts were the decisive factors that prompted us to register on e-connect,” as Antonin Janca, Maintenance Manager at Teknia Uhersky Brod, reported during his visit to ENGEL’s headquarters in Schwertberg.

The cup with the kink ENGEL Packaging Day 2019 in Shanghai

More than 80 attendees accepted the invitation to the 2019 ENGEL Packaging Day in Shanghai. The injection moulding machine manufacturer hosted live demonstrations to highlight innovative and intelligent solutions for efficient packaging production. “In China, there are increasingly higher standards expected for the quality of products and, in turn, packaging – especially in the food industry,” said Kurt Hell, Head of ENGEL’s packaging business unit in Asia. “Special designs and functional properties are in demand, as is high-quality decoration...”
with in-mould labelling. Multi-colour and multi-component applications for caps and closures in the food and non-food sectors are also becoming more popular.” During the event in its technology centre at the Shanghai plant, ENGEL demonstrated on a fully electric e-mac 180 injection moulding machine how 2-chamber yoghurt containers with IML decoration can be produced in both an efficient and highly cost-effective way.

**Preparing young talents for industry 4.0**

**ENGEL North America equips universities**

The shortage of skilled workers in the plastics industry is noticeable worldwide and requires even more commitment on the part of companies in promoting young talent. In North America, ENGEL equipped another four universities with injection moulding machines in the first half of 2019. At the University of Massachusetts Lowell, Pittsburgh State University located in Pittsburg, KS, Penn State Behrend in Erie, PA and the University of Wisconsin-Stout, students can now access a tie-bar-less and all-electric e-motion TL injection moulding machine with an e-pic Z robot and an extensive package of inject 4.0 products for training and research. In addition, each institute received training on the subject of the smart machine. “Smart machines are the future of manufacturing,” says Bradley Johnson of Penn State Behrend. “Our students benefit greatly when they learn how to achieve consistent component quality using adaptive technologies. Many users of injection moulding machines do not take advantage of all the possibilities that are at hand within the machine. The best way to change that is through education.” “We are convinced that advanced sensing and system control is critical to enabling new applications which determine competitiveness,” says David Kazmer, Professor at the University of Massachusetts Lowell. “It is important to us that our students and industry partners be up to date on the latest technologies.”

**More than 300 participants**

**Technology Symposium at ENGEL Polska**

The latest edition of the ENGEL Polska Technology Symposium in Warsaw attracted 300 participants, making it a huge success. For a whole week, both ENGEL customers and students were able to experience live at the technical centre what opportunities innovative processing technologies, automation, digitalisation and connectivity open up for the current and future challenges of injection moulding. In addition to an exciting keynote programme, there were live exhibits. Among other products, two-part callipers were produced in a highly integrated and automated production cell. The special feature of this application is fully automated mould insert changes which take only one minute, making injection moulding highly economical even for small batches of less than 1,000. Around 100 students from the five largest polytechnic universities in the country accepted the invitation to visit the ENGEL subsidiary. ENGEL Polska has a strong tradition of supporting engineer training.

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Full house at the ENGEL Lightweight Future Day 2019

High-ranking experts, new challenges and lively discussions – the Lightweight Future Day, to which ENGEL invited to Schwertberg in May, was just as varied as the applications for lightweight technology. Lightweight and composite technologies are a major topic for the future. The great interest in the event clearly reflects this trend. More than 130 participants came from many different industry sectors – from the automotive and automotive supply industry, aviation, the construction and civil engineering industry to education and research institutes.

The participants at the Lightweight Future Day all agreed that lightweight technology is a major enabler to master the challenges of the future, for example to achieve reductions in carbon dioxide emissions. Dr Umut Çakmak, Managing Director of Plastics Innovation GmbH and scientist at the Institute for Polymer Product Engineering at the Johannes Kepler University in Linz, stated: “If we consider efficiency and carbon footprint of components right from the start, that does not only have an impact on material properties but also on energy consumption. What is particularly exciting in this context is the rising significance of thermoplastic structural components and their potential for efficient serial production by integrating functions.”

Increasing demand for thermoplastic solutions
During the full-day of the event, particular importance was given to composite lightweight technology based on thermoplastics. The thermoplastic approach enables highly integrated and fully automated manufacturing processes and simplifies managing circular economy. However, it is also the costs that increase the demand for thermoplastic solutions, as Dr Christoph Stehrecken, Head of R&T Composites at Premium Aerotec, explained in his presentation. For example, if aluminium is replaced by thermoplastic components, the number of pieces used for the rear pressure bulkhead on an Airbus A320 can be reduced from 149 to 40, as initial studies show. Of course, this drastically reduces assembly time and therefore costs.

Functional integration is another prime topic which explains the rise in demand for thermoplastic-based technologies. “At KTM-Technologies our research efforts are currently aimed at functionalisation and hybridisation since the focus is no longer on composites only but on combining them with other materials,” explains Maja Labentz, Sales and Account Manager at KTM-Technologies.

“Leveraging synergy effects
The Lightweight Future Day not only covered established applications but also provided a visionary outlook into the future. The German Aerospace Centre drew widespread attention when it presented a prototype for a mobile production robot for fibre placement. The self-propelled fibre-placement robot – based on the principle of a robotic lawn mower – offers potential for large-area fibre composite surfaces such as sails and building structures or even in automotive for the production of several different components in a single work step.
It is precisely this blend of applied technologies, visions and insights into various industry segments that made the Lightweight Future Day a successful event. The general tenor was that the industry experts could learn a lot about lightweight technology from each other and that in future, interfaces between the companies would play an ever greater role. Whereas synergy effects were not fully utilised in the past, the industries are now starting to share experience and expertise more frequently.

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“Increasing demand for thermoplastic solutions
During the full-day of the event, particular importance was given to composite lightweight technology based on thermoplastics. The thermoplastic approach enables highly integrated and fully automated manufacturing processes and simplifies managing circular economy. However, it is also the costs that increase the demand for thermoplastic solutions, as Dr Christoph Stehrecken, Head of R&T Composites at Premium Aerotec, explained in his presentation. For example, if aluminium is replaced by thermoplastic components, the number of pieces used for the rear pressure bulkhead on an Airbus A320 can be reduced from 149 to 40, as initial studies show. Of course, this drastically reduces assembly time and therefore costs.

“The trend in product engineering is towards hybridisation and load-specific component design. Materials are used where they can best utilise their potential strengths.”
Dr. Umut Çakmak, Plastics Innovation

“Our research efforts are currently aimed at functionalisation and hybridisation since the focus is no longer on composites only but on combining them with other materials.”
Maja Labentz, KTM-Technologies

Leveraging synergy effects
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New ENGEL technology centre makes the smart factory a hands-on experience

ENGEL AUSTRIA has opened its new “ENGEL Technology Centre. Innovation at heart” at its headquarters in Schwertberg. “We have created our own pilot plant for vertical integration in injection moulding and can support our customers even more comprehensively on their way to implementing the smart factory,” says Dr Stefan Engleder, CEO of the ENGEL Group. The new customer technology centre is the heart of the latest expansion at headquarters.

Featuring 1,700 m² of machine floor space, the ENGEL technology centre is a plastics processing facility in its own right and one of the most modern in the world. “We are the first users of all newly developed injec 4.0 technologies,” says Engleder. ENGEL bundles its products and solutions for the smart factory under the name injec 4.0. The portfolio is continually being expanded. “The aim of injec 4.0 is to leverage the full potential of machines, systems and technologies in order to strengthen competitiveness, act more flexibly and master the increasing complexity of production,” Engleder points out. “With the new possibilities of our technology centre built for our customers, we are able to demonstrate in a powerful and tangible way how this great potential can be efficiently and economically leveraged, in line with the individual requirements of the processors.”

Process optimisation across multiple locations
Vertical integration describes the integration of all machines, systems and manufacturing processes within a company or manufacturing network into a high-level control system. The ENGEL technology centre provides practical demonstrations of integration beyond the boundaries of a single location, as it is connected to the technology centres at ENGEL's plants and subsidiaries worldwide. “From Schwertberg, we can monitor and remotely maintain the production cells in China, Mexico or Germany, for example,” says Engleder. Key products for this are the ENGEL econnect customer portal and TIG authentig. The Manufacturing Execution System (MES) by ENGEL subsidiary TIG, uses a cloud solution to make all machines within the production network transparent. This means that, for
example, machine utilisation can be optimised across multiple locations.

First user of the latest technologies
In addition to transparency, intelligent assistance systems make a major contribution towards improving production efficiency in the smart factory. All the machines in the new ENGEL technology centre are equipped with a wide variety of assistance systems from ENGEL’s iQ product family. In addition to iQ weight control, iQ clamp control and iQ flow control, which have been very successfully established in injection moulding companies for some time now, the brand-new iQ systems, which ENGEL will be presenting at K 2019 in Düsseldorf in October, are utilised at the technology centre. “Innovation at heart” is not only part of the new technology centre’s name, but also the guiding strategy. “At the technology centre, we show what is possible today and what we will make possible in collaboration with our customers in the future,” emphasizes Engleder. One of the forward-looking projects focuses on establishing a knowledge database which pools expertise and experience within the group. “In the future, knowledge databases will empower us to solve the challenges of injection moulding even faster and more decisively,” says Engleder.

Horizontal connectivity: the next step
Digital transformation is another forward-looking topic. The individual vertical platform solutions are connected with each other horizontally along the value chain. Where vertical networking is about function-related and mostly domain-specific optimisation of the individual stages in the value chain within a company, horizontal networking allows processes to be optimised across functions along the entire value chain. A horizontal networking pilot factory – LIT Factory – was opened in Linz/Austria at the beginning of June.

LIT Factory
Progressive research projects, interdisciplinary exchange, close networking between university, industry and economy - with the opening of the LIT Open Innovation Center and the pilot factory, LIT Factory, a unique research and development center celebrated its birth in June at the Johannes Kepler University in Linz. The goal of the university is to become one of the most modern universities in Europe. The LIT Factory’s aim is to use digital system models to research and further develop product creation processes along the value chain – from materials to product development, and from production to recycling. The focus is on lightweight technology, digitalisation and end-to-end solutions. In addition to ENGEL, 24 other companies, primarily from the Austrian and German economic areas, are involved in establishment of the LIT Factory. Thanks to participation of various disciplines such as mechatronics, IT or environmental technology, and to the support of various industrial partners, it is possible to cover the plastics industry’s entire value chain in a single factory. The resulting synergies, for example, the joint use of research results, contribute significantly to the further development of digitalisation competency.

Lightweight technology is the focus at LIT Factory. ENGEL has equipped the pilot factory with an integrated plant for the production of thermoplastic composites, including a tape stacking unit.
30 years of tie-bar-less technology:
Success story with a bright future ahead

When it comes to the unparalleled success story of ENGEL’s tie-bar-less technology, the numbers speak for themselves, with more than 70,000 machines in the hands of around 10,000 customers. It was first released 30 years ago at the K show in 1989 and is currently enjoying a true resurgence. ENGEL’s tie-bar-less injection moulding machines are able, like no other machine design, to combine cost-effectiveness and efficiency with minimal resource consumption.

Great and continuing success was by no means assured for tie-bar-less technology. When ENGEL was the first injection moulding machine manufacturer in the world to exhibit an injection moulding machine with a tie-bar-less clamping unit in Düsseldorf, Germany, the innovation was met with both widespread astonishment and deep scepticism. There seemed to be many reasons to doubt this new method. Until then, it was regarded as a firm design principle that an injection moulding machine had to have four tie bars.

The idea for the new solution came from the processors themselves. Especially when using large moulds, the tie bars would curb the creative freedom of mould manufacturers. Mould mounting and removal through the four tie bars is rather complicated. “Even back in the 1980s, these restraints could not be reconciled with the demand for more efficiency in manufacturing,” stresses Stefan Engleder, CEO of the ENGEL Group.

As a result, the highly flexible mould area and simple mould changing offered by the tie-bar-less machine even tempted the sceptics to try the unconventional design – and they were impressed by the results. Interest from the industry was soon so great that the tie-bar-less machine became the predominant design at ENGEL’s main production plant in Schwertberg, Austria. Within a few years, it turned into a full machine series, which was dubbed “victory” based on it’s victorious triumph.

“Saving resources with smaller machines
“The market quickly recognised that this barrier-free clamping unit does more than just make mould installation simpler,” reports Gerhard Dimmler, senior vice president of product research and development at ENGEL AUSTRIA. “Other benefits of tie-bar-less technology include improved ergonomics for all manual work in the mould area, more flexible automation solutions with the robot able to directly reach the cavities from the side, and more compact production cells with lower capital investment and operating costs.” The particularly large mould-mounting platen areas are the key to boosting productivity per unit of area. Since there are no tie bars in the way, the platens can be utilised up
to the very edge. This means that large moulds can fit on relatively small machines. “In many cases, you can pick a machine that is one or two levels lower in terms of clamping force than that which would be necessary for the mould on a conventional machine with tie bars,” emphasises Franz Pressl, product manager for hydraulic tie-bar-less machines at ENGEL AUSTRIA. “By using less energy and coolant, a smaller machine significantly helps to conserve resources. Another plus is the ideal utilisation of production floor space, given that shop floors often have to accommodate several machines. “It is impressive how many of our customers are using tie-bar-less technology to its full potential, giving them a substantial competitive advantage,” Engleder says.

For instance, there is particularly high potential for efficiency with multi-cavity moulds, multi-component processes with in-mould core-pulls and slides, and ENGEL’s foammelt structural foam moulding, all of which require little clamping force for their respective mould volumes.

Even surface pressure throughout the mould mounting platen
Thanks to the consistent patent protection for tie-bar-less technology and all its improvements, it has remained a unique selling proposition for ENGEL to this day. One area in which some important milestones have been achieved is the joint on the moving platen, which is known as the force divider in the current generation of machines. The force divider ensures that the moving platen follows the mould in a perfectly parallel manner during clamping force build-up and guarantees that the clamping force is evenly distributed across the entire platen area. Therefore, the parting lines of cavities at the edge experience the same surface pressure as cavities in the centre, which prevents flash, even when processing low-viscosity liquid silicone rubbers.

Efficient standards to meet specialised needs
ENGEL’s tie-bar-less technology is continually adapting to the changing needs of processors. Key milestones along the way have included the 2004 launch of the e-victory hybrid machine featuring an electric injection unit, the servohydraulic ecodrive introduced in 2008 which has since been included as a standard feature, and the current generation of injection units which has been taking the processing precision and efficiency of hydraulic machines to the next level since 2016. ENGEL has also been offering all-electric tie-bar-less solutions since 2013. The second generation of injection moulding machines in the all-electric e-motion TL series was engineered specifically for the production of high-precision optical and electronic components. These machines have had great success establishing themselves in the consumer electronics industry, including the production of smartphone lenses and seals. “We’re taking a strongly application-focused approach to the further development of all-electric tie-bar-less technology,” Dimmler reveals. “Thanks to flexible solutions for highly specific products and materials, we will be further improving cost-effectiveness, efficiency and sustainability in production through the use of tie-bar-less injection moulding machines. In this context, there is an increasing focus on smart technologies such as intelligent assistance systems.”

“IT is impressive how many of our customers are using tie-bar-less technology to its full potential, giving them a substantial competitive advantage.”
Stefan Engleder, CEO ENGEL
**ENGEL automotive at K 2019**

**Producing ultra-efficient thermoplastic composites with targeted load distribution**

At K 2019, ENGEL will be taking the next big development step in the large-series production of thermoplastic-based lightweight composites. At the show, ENGEL will be using the organomelt process to produce demo parts that reflect the latest innovations for car door modules. The production cell is the first in the world to use infrared radiation to heat up and form three organic sheets of differing thicknesses, as well as shaping a high-quality visible surface in the same injection moulding process stage.

“Thermoplastic composites are growing in importance when it comes to lightweighting in the automotive industry,” reports Dr Norbert Müller, head of ENGEL’s Center for Lightweight Composite Technologies. There are two main reasons for this. Firstly, the consistent thermoplastic approach makes it possible to efficiently integrate the forming and functionalisation of fibre-reinforced prepregs, which reduces unit costs. Secondly, the use of exclusively thermoplastic polymers makes it easier to develop recycling strategies. ENGEL’s answer to the need for sustainable transport is organomelt. In the organomelt process, fibre-reinforced prepregs with a thermoplastic matrix such as organic sheets and tapes are heated, inserted into the mould, formed there and directly overmoulded with thermoplastic. The well-developed process has already been used in high-volume manufacturing, with ENGEL organomelt used for fully automated production of items such as front end carriers. As this process undergoes further development, ENGEL is working together with its customers and partners on the production aspects of designing composite components with a targeted load distribution. “In the future, several different prepregs will be combined for each component to tailor the lightweight construction characteristics to the relevant component’s shape as well as the different stresses on individual areas inside the component,” Müller explains. “The production cell at the K show will clearly demonstrate that great potential.”

The moulding process to be exhibited at K was developed in partnership with automotive supplier Brose. This is currently the only system in the world that can simultaneously process three differently shaped organic sheets between 0.6 mm and 2.5 mm in thickness in a fully automated process involving integrated IR ovens. The different stresses on the individual component areas can be dealt with thanks to the targeted selection of organic sheets on the basis of load distribution – an outcome that Brose has helped to ensure through a variety of simulation processes. The demo part to be produced at the K show, for instance, is more rigid in its window frame area than on the inside of the door.

**Ultra-compact IR oven integration**

One of the challenges with processing organic sheets is the heating of the prepregs. The time they take to heat and cool depends on their thickness. Heating the material quickly without damaging it is important, as is a fast and straightforward transition to the mould for the heated prepreg. The organomelt production cell to be featured at K is based on a duo 3660/800 injection moulding machine and includes two integrated IR ovens for this reason. There is a vertical IR oven positioned directly above the clamping unit to heat up the organic sheet, which is only 0.6 mm thick. This way, the thin organic sheet reaches the mould in practically no time, ensuring that it has not yet cooled down and become impossible to form. A standard, horizontal IR oven on a pedestal above the moving platen will be used for the two thicker organic sheets (1 mm and 2.5 mm). This arrangement shortens the distance between the oven and the mould, as well as saving space since the oven does not need separate floor space. Both of the IR ovens were developed and manufactured in-house by ENGEL.
These and the three easix robots are fully integrated with the IMM’s CC300 control unit and can be centrally controlled via the machine’s display. The organic sheets, which were obtained from Chinese raw material producer Kingfa, are made of glass fibres and use polypropylene as their matrix material. When the mould – built by Georg Kaufmann Formenbau – closes, the organic sheets are formed. Immediately afterwards, they are overmoulded with glass fibre-reinforced polypropylene within the same mould. Reinforcing ribs are shaped on the back of the component, while a leather-look grain is shaped on the visible side. “When directly overmoulding the organic sheets, we can achieve an outstanding grained leather look, which was previously seen as impossible when it came to organic sheets,” Müller stresses. “In that regard, we’re laying the foundation for producing large structural thermoplastic door structures using the organomelt process in the future.” The production solutions developed by ENGEL at its Center for Lightweight Composite Technologies are distinctive for their high efficiency and cost-effectiveness. ENGEL’s considerable expertise in automation plays a major role here. With three ENGEL easix articulated robots all operating at the same time, the organomelt cell at K 2019 will provide a truly state-of-the-art example of integrated composite processing.

Autonomous driving: foil applications increasingly in demand

Autonomous driving is presenting new challenges in a vast number of different areas for car manufacturers. Firstly, vehicle interiors will change, needing to become more homelike with controls replaced by high-quality surfaces. Secondly, autonomous driving will require brand-new sensor technology that can be unobtrusively made a part of the design. In both instances, there is a growing preference for foil applications as the production solution. With foilmelt and clearmelt, ENGEL has two extensively tried-and-tested technologies used for the processing of both functional and design foils. At K 2019, ENGEL is demonstrating the amazing flexibility of the production-ready, roll-to-roll IMD injection-moulding process by producing complex, three-dimensional sample parts with different decor on a victory 300 injection moulding machine. The joint development by system partners ENGEL, Leonhard Kurz, Schöfer and Isosport Verbundbauteile makes it possible to thermoform, back inject and die-cut a limitless selection of surface systems from roll to roll in the mould in this one-step process. The wide range of possible material combinations is remarkable.

Lighting: the ultimate clean look for optical fibres

LEDs are becoming more and more versatile in their use in vehicles, increasingly being added as distinctive design elements. The level of variation in their shape is growing accordingly, creating new challenges for optical fibre manufacturers. ENGEL has developed a new plasticising process specifically for PMMA processing to ensure high luminous efficiency, even in cases featuring complex shapes and long structures, such as outline lighting. This increases the homogeneity and purity of the melt, making new options available to lighting designers. To highlight the great potential, an all-electric and tie-bar-less e-motion 120 TL injection moulding machine will be put through its paces at K. ENGEL has joined forces with its development partners iNglass and HRS-flow to test out a variety of injection systems with electrically operated needle valves, and will be exhibiting a solution that has been fine-tuned in every detail. The other partner companies that have been helping to make the exhibit possible are Volvo and Arkema.
ENGEL AMM: Amorphous metals combined with polymers for the first time

ENGEL and Heraeus have managed to reduce cycle times by up to 70% compared with previous production solutions for the processing of amorphous metals in injection moulding. In doing so, the two system partners have opened the door to these alloys with truly special qualities entering large-scale production for a wide assortment of end uses. ENGEL is presenting the next big step in this development at the K 2019 trade fair in Düsseldorf, Germany, between October 16th and 23rd. Two-component parts made of amorphous metal and silicone are produced for the first time – a process that is taking place in a fully automated manufacturing cell.

Due to their randomly arranged, non-crystalline structure, amorphous metals are both extremely hard and highly elastic. They have very good elastic recovery, are extremely corrosion resistant and biocompatible according to ISO 10993-5. With this combination of properties, these alloys are superior to steel, titanium and many other materials. On the basis of its proven hydraulic and tie-bar-less victory range, ENGEL has developed a new injection moulding machine for processing amorphous metals from Heraeus’ Amloy product range. The ENGEL victory AMM – amorphous metal moulding – delivers fit-for-purpose parts with a premium quality surface finish within very short cycle times.

Fully automated process

For the production of two-component housing demo parts at the K show, ENGEL is combining a victory 120 AMM with an insert 60V/45 vertical injection moulding machine, which is equipped with a two-station rotary table. The manufacturing cell is fitted with both an ENGEL viper linear robot and an ENGEL easix articulated robot for the fully automated production process. The first step involves injection-moulding the basic structure for the housing on the victory AMM from a zirconium-based Amloy alloy. To do this, the viper robot takes an Amloy pre-material from the separator and transfers it to the injection unit. After less than 70 seconds, the metal component takes full shape. The viper removes the part and deposits it onto a tray. The easix articulated robot takes over from there, placing the Amloy component on the lower mould half on the insert machine’s rotary table, where a liquid silicone rubber (LSR) seal is moulded on the part. The elastomer component also consistently fills out the seal structure on the bottom of the part through narrow openings on the surface of the housing. Both of the moulds are made by long-term ENGEL partners, Flex and Starlim Sterner.

Geared for high-volume production

The demo parts combine the needs of portable electronic devices with the innovative properties of the Amloy materials. In addition, two-component injection moulding opens up new opportunities for designing housing frames that are almost indestructible while enjoying better protection from dust, water and radio waves. Fully automated hybrid production is unlocking huge potential, especially for the consumer electronics industry. Our development work has confirmed that, in multi-component injection moulding, it is possible to create stable combinations not only of silicone, but also of other elastomers and thermoplastics with Amloy materials. Zirconium-based and copper-based alloys for large-scale applications are currently available in the Amloy product line, with alloys based on titanium, iron and platinum also in the works. With this variety of materials, Heraeus and ENGEL cover a huge range of new applications. The list includes portable electronic devices, durable instruments for minimally invasive surgery, stable suspension and wear-resistant drivetrain components for the aerospace industry, premium decor elements for cars, and abrasion-resistant watch components.
ENGEL medical: Shorter cycle times for thick-walled housings

Sometimes, more is less. With the aim of further reducing cycle time, ENGEL has split the process of producing housing parts for medical devices using two-component injection moulding. At its stand at K2019, ENGEL demonstrates what this looks like under realistic production conditions.

“The key thing with housing parts is the cooling time,” explains Dr. Georg Steinbichler, senior vice president of research and development for technologies at ENGEL AUSTRIA. “Since the wall thickness cannot be decreased for stability reasons, conventional one-component production leaves no opportunity to reduce the cycle time. But in the two-component process, we inject two thin layers, each of which quickly cools. Since both injection moulding steps are carried out at the same time, overall production efficiency increases.”

Part removal from closed mould
A Hack Formenbau 8-cavity Vario Spinstack mould on the cleanroom version of an all-electric e-motion 310H/170W/160 combi injection moulding machine is used for this purpose at ENGEL's stand. It is equipped with a vertical indexing shaft with four positions: the first for injection moulding the bodies, using a transparent polypropylene from Borealis; the second for cooling; the third for applying a second layer of polypropylene – this time coloured green – to the pre-moulded parts; and the fourth for a viper 20 speed robot to remove the parts. The linear robot reaches down to remove the eight housing parts from the closed mould, contributing to the extra-short cycle time.

Another advantage of the two-component process is that a sight glass can be added to the opaque housing as it is being injection moulded.

New software paving way for servoelectric moulds
The two-component precision mould is fully servoelectric in its operation and is the first to use a software programme newly developed by ENGEL. This ensures that the servoelectric movements – core-pull movements, for instance – can be controlled in the same way as those of hydraulic systems. “With the software’s help, it makes no difference to machine operators whether the mould is hydraulically or servoelectrically operated,” says Dr. Gerhard Dimmler, senior vice president of product research and development at ENGEL AUSTRIA. “We are paving the way for increased use of servoelectric moulds. They are more precise in many applications and allow for completely oil-free production when combined with all-electric injection moulding machines.”

Another star in line for its world premiere is the ENGEL compact cell, which is the key reason for the production unit’s small footprint. Despite being home to all the automation components, the compact cell is still significantly slimmer than a standard safety guarding. Its standardised design makes it very simple to add in extra components, while allowing for speedy converting during a product change.
ENGEL is bringing the smart factory to life with its inject 4.0 range of products at the K 2019 trade fair. Two new assistance systems, iQ process observer and iQ melt control, are making their world premiere in Düsseldorf, Germany.

**iQ melt control: an even gentler plasticising process**

ENGEL’s second new iQ development makes it possible to perfect the plasticising process. The goal of iQ melt control is to conserve both the material processed and the mechanical components of the plasticising unit to the greatest extent possible. “In real-world situations, plasticising is often faster than required by the cycle,” reports Günther Klammer, head of the Plasticising Systems division at ENGEL AUSTRIA. “This generally has an effect on the screw’s service life and part quality.” Improved melt homogeneity, on the other hand, increases process reliability. iQ melt control automatically determines the optimum plasticising time for the specific application. Instead of plasticising at the maximum possible speed, the system makes full use of the part’s in-mould cooling time for plasticising. The machine operator only needs to enter the screw type and the material to be processed. Next, along with the optimum plasticising time, you receive recommendations for optimising the temperature and back pressure.

The better the process parameters are set for a specific production run, the quieter the screw’s operation – making the upcoming trade show demonstration all the more striking. The benefits for the processor are a longer service life for the screw and a constantly high melt quality, which subsequently improves part quality and increases efficiency.

**iQ clamp control now available for the victory**

Until now, iQ clamp control has only been available for the all-electric e-motion and duo large-scale machines. At the K show, the software will be used for the first time on a tie-bar-less victory machine. It is now available for all main ENGEL series. iQ clamp control calculates mould breathing, determines the optimum clamping force based on that information, and automatically makes the process adjustment required. Users benefit from consistently high part quality and superior mould ventilation, which improves efficiency and machine availability, especially in the cases of frequent mould set-ups.

**iQ flow control: e-temp with higher performance**

In order to further reduce the space required for temperature control equipment, ENGEL is presenting its new 4 e-temp temperature control unit at K 2019. Initially larger than the previous e-temp models, size 4 features a higher pump capacity, making it possible to replace several smaller temperature control units operating at the same temperature with a single temperature control unit. The total space required can consequently be reduced. This all leads to reduced energy consumption, necessary cost for piping and investment costs. The e-temp temperature control units which ENGEL developed in collaboration with HB-Therm for K 2016 can be integrated with the injection moulding machine’s CC300 control unit via OPC UA with the aid of the iQ flow control assistance system. iQ flow control is capable of dynamically regulating the pump output and water volumes, keeping the temperature control conditions constant.

**e-flomo: New feature accelerates mould set-up**

As the optimum electronic water distribution system for managing mold temperature, e-flomo premium, will be on display in Düsseldorf. Automated, sequential purging of the distribution circuits in the mould ensures that any water and dirt present in the temperature-control channels are completely removed before the mould or
ENGEL is starting a completely new chapter in the development of intelligent assistance at the K 2019 show with iQ process observer. To date, assistance systems have been used to optimise individual steps in the injection moulding process, such as injection and cooling. But the new iQ process observer goes several steps further, providing an overview of the entire process for the whole batch. This makes it possible to identify changes in the process at an early stage, allowing operators to determine their causes and find a solution more quickly. The software continually analyses several hundred process parameters across all four phases of the injection moulding process – plasticising, injection, cooling and demoulding. The results, split into the four phases, are immediately visible in an easy-to-understand overview on both the injection moulding machine’s CC300 control unit and the ENGEL e-connect customer portal.

The software automatically detects deviations by constantly comparing the results against the previous cycles, as well as certain process parameters with a set reference condition. The system also notifies the machine operator of improvable process settings and conditions, in addition to possible causes via text message. This helps the user to optimise their processes and, when necessary, to resolve errors. All the functions run automatically. The iQ process observer requires zero set-up effort.

“By using the iQ process observer, process technicians can maximise the potential for efficiency and quality offered by the injection moulding machine and production cell,” says Paul Kapeller, product manager for digital solutions at ENGEL AUSTRIA. “The iQ process observer is currently the only assistance system on the market based on live data, which actively indicates changes in the process and ineffective settings, helping to improve stability throughout the process.”

The mould insert is removed. When mounting the mould, this innovation ensures optimum ventilation of the temperature-control channels. The automated process saves time compared to conventional purging and also makes it possible to extend the time between required maintenance for the mould. Since compressed air often does not flow uniformly through all channels during manual operation, residual water can remain in the channels and lead to corrosion. This risk is eliminated to a great extent by automation.

**iQ weight control: Fully leveraging the potential for large-surface parts**

Cascade injection is a new feature of iQ weight control. It makes it possible to adjust the quality-relevant process parameters at several injection points connected in series. After filling at the first injection point, the system first switches to the second and all further injection points; it then only switches to holding pressure at the end of the cascade. In injection moulding of parts with a large surface area and long flow paths, for example, bumpers, the potential of iQ weight control can be fully leveraged in this way.

**e-connect customer portal now available worldwide**

In time for K 2019, ENGEL is completing the roll-out of its new customer portal, e-connect is now available free of charge to all ENGEL customers worldwide. In order to optimally meet the new and rapidly changing requirements of digitalisation and connectivity, ENGEL has completely revised the portal and integrated the smart service products. And the scope of features continues to evolve with the addition of push notifications and edge device management.

The fastest link to the world of ENGEL: the e-connect customer portal is currently available in 13 languages.
Injection moulding machines with assistance systems open up new possibilities for even higher process accuracy and product quality. Such intelligent software solutions adjust the process parameters cycle by cycle based on current conditions. One example is iQ weight control by ENGEL, which automatically compensates for external influences such as fluctuations in the raw material. The challenge for medical technology, however, is to integrate this process control into the validation process. Different approaches were examined and a procedure designed which makes it possible to validate processes with iQ weight control in compliance with both EN-ISO and FDA.

For medical products, the regulating groups (also known as Notified Bodies) of the EU and the USA require detailed documentation during the entire product development, process planning and manufacturing process. The requirements can be found in the European standard “EN ISO 13485:2016 – Quality management systems for medical devices” and in the American FDA regulation “21 CFR Part 820 – Quality Systems Regulations”. Both regulations stipulate that a company must validate critical production processes of results that cannot be verified by subsequent monitoring or measurement. This includes injection moulding processes in mass production, where 100-percent inline inspection is usually not logical. However, the implementation of the validation is not specified either in the American regulation or in the European standard. Only the tasks to be performed by the manufacturer are recorded in various directives and guidelines.

It is common practice to validate injection moulding processes based on machine parameters. However, changing ambient conditions that influence the viscosity of the melt and can lead to rejects are not considered. Many processors are asking themselves how the new process control can be integrated into a validation strategy for the manufacture of medical technology products in compliance with current laws and standards. The key lies in the definition of process windows and the validation of these processes. ENGEL iQ weight control offers the possibility of limiting the scope of modifications. Based on experience or test results, limit values are determined for the adjustable parameters switchover point, injection profile and holding pressure, respectively, and are stored in the control system. This ensures that the process parameters do not fall outside of the validated range despite dynamic process control, and that the process complies with the regulatory requirements.

Adapt the validation strategy to the product
First, product requirements must be defined by measurable acceptance criteria. This is usually done based on the risk analysis and is described in a validation master plan (VMP). The VMP contains the validation strategy of a company and should clearly define the key elements of the qualification and validation program. The VMP must also describe very specifically which validation principles are implemented in the company and how, and who assumes the responsibility at which level and in what form. This task should be performed by a group of experts, known as the Task Force, consisting of product and process engineers at the plastics processor. Every product has critical quality attributes (CQA), which in injection moulding production can be, for example,
a linear measure or the surface quality. In the validation, it is necessary to find the corresponding critical process parameters (CPP) that affect the CQA. The experts define these critical injection moulding parameters based on data sheets and figures created on experience with comparable injection moulding processes. In the case of critical components such as functional elements of a drug delivery system, the statistical design of experiments (DoE) is used to determine the process limits. For the majority of applications, simplified planning based on empirical values is sufficient to define a permitted parameter window. If the CQA are within the accepted limits, parameter ranges in which the process can be adapted can be set. In addition, the stability of the process is examined in this phase.

Control process parameters in real time
The iQ weight control assistance system is a real-time control software that adjusts process parameters during production to ensure consistent high part quality. The software compares the injection pressure above the screw position with a reference pressure curve and identifies deviations in injection volume and viscosity. The automatic adjustment of the switchover point, injection profile and holding pressure compensates for target deviations shot by shot. Consequently, the switchover point and holding pressure level must be defined as CPP in the validation strategy.

The limit values for the switchover point and holding pressure determined in the DoE are adopted in the CC300 controller of the ENGEL injection moulding machine as the limit value for process control by of iQ weight control. If it is necessary to regulate the parameters outside of the validated limits in order to achieve the specified product quality, a corresponding procedure can be defined in the control system. For example, the respective shot can be declared as scrap or the production process can be stopped if the limit values are exceeded. Simplified rules are also possible. For instance, by keeping the switchover point constant and adjusting the holding pressure, or vice versa, keeping the holding pressure constant and adjusting the switchover point.

The validation strategy described makes it possible to use intelligent assistance systems in medical technology as well, in order to further increase process consistency and process reliability. This allows quality fluctuations of the raw material and changes in ambient conditions to be dynamically and reliably compensated for in the validated process. Using simple logic, the innovative algorithms used by intelligent assistance systems can be integrated into the validation strategy.

European standard and American law
There are many similarities between European and American standards. Nevertheless, there are differences to be noted: The Americans have higher documentation requirements, and the logical grouping of documents is also unknown in EN ISO 13485. Conversely, the European focus on customer satisfaction and continuous improvement of the QM system goes beyond the requirements of 21 CFR part 820. Furthermore, there are significant differences in the handling of complaints and the reporting system. The FDA does not accept ISO 13485 certification as proof of compliance with the requirements of 21 CFR part 820. In contrast to ISO 13485, there is also no certification according to 21 CFR Part 820.
Dynamic injection – made easy

Injection is the process step in injection moulding that is most critical. The injection speed profile and its repeatability have a direct influence on the internal and external properties of a part. The adjustment of the injection step is therefore of particular importance. ENGEL injection-moulding machines with electrical injection units now feature optimized setpoint calculation of this profile, with a clear illustration, which increases the process transparency and ease of operation.

In automotive technology, it has long been normal to adjust the driving behaviour from the cockpit. Various driving programs, from comfort to sport, are generally available. The vehicle electronics change the characteristics of the engine, gearbox, chassis and steering, depending on the desired program. Driving pleasure is just a matter of simple settings.

Smooth or dynamic? ENGEL AUSTRIA is now making it just as easy and convenient for users to set the profile dynamics of their injection moulding machines in the CC300 control system. With an intuitively operable slider, the dynamics of the profile set by the machine operator can be adjusted – from smooth to highly dynamic (Fig. 1). The injection movement can thereby be individually adapted to the process requirements, from the production of optical lenses with high requirements to smooth transitions for filling, through to highly dynamic packaging application.

At the core of the new setpoint calculation is an optimized algorithm. From the setpoint profile specified by the user – taking into account the physical limits, such as the permissible acceleration and changes of acceleration – this algorithm computes a feasible speed profile. The algorithm intuitively implements the operator’s settings as a target speed. In the development of this new function, particular attention was paid to the transparency of the machine behaviour.

Expected speed profile before the first cycle

Even in the previous CC200 control system, the injection speed profile was entered either numerically or graphically by sliding profile points on the touchscreen. However, in the detail views, the actual value curve was first shown separately from the setpoint values on different screen pages. The relationship between the setpoint and actual values was consequently not immediately apparent.

A new feature is that the algorithm pre-calculates an actual value profile, which, before the first cycle, gives feedback to the plant operator about the effects of changes of setpoint values and profile dynamics on the injection speed. This increased transparency considerably simplifies the setting of the application-specific optimum injection profile. Where the machine operator makes the setting, he is already provided with information about the effect of his action and thereby achieves his goal faster.

In the case of a position-dependent changeover from injection to holding pressure, the injection time to be expected is also displayed (Fig. 1). The injection time can

Ready to use with tutorial

A tutorial is also available for the newly optimized setpoint computation. It guides machine operators in an easily understandable way through the operating principles, the application and the benefit of the new solution.

ENGEL is now equipping all injection-moulding machines with electrical injection units with an optimized setpoint computation for the injection speed profile.
be aligned with a target value by adjusting the speed profile. This eliminates the need for labour intensive preliminary trials, which take time and produces reject parts. The target value may be an empirical value or else a recommendation by the mould maker. If settings data are transferred from one machine to another, the preliminary calculation of the injection time also offers valuable help.

**Input merges with the output**

Before the first cycle, where an actual value curve is not yet available, the speed profile to be expected is displayed. Immediately after the first cycle, the set-point profile is compared to the actual value profile. In practice, it has been found that, thanks to the precise speed control, the actual value profile is almost identical to the calculated profile: the input merges with the output (Fig. 2).

The graphic display in the CC300 shows all the important information at a glance. The injection profile is displayed from right to left, corresponding to the direction of screw movement. The green lines represent the speed curves and the red line, the pressure curve. Setpoint values, actual value curves and calculated profiles are differentiated from one another by means of different line types. Coloured background marks provide valuable additional information. Here, green also stands for the speed control.

The dark-green area at the start of the injection stroke shows the elapse of the decompression step. Mould filling generally does not occur at this point. In this area, the speed influences the closing of the non-return valve. The red area indicates the pressure control. It shows the holding pressure phase and possible intervention by the pressure limit controller. Perceptible deviations then only occur if, because of the high injection pressure requirement, the speed is reduced via the pressure limit controller. This case is immediately displayed in the machine control and the plant operator is notified of possible problem areas. (Fig. 3).

The changeover point actual value is marked by a line. To the left, in the holding pressure range, the speed setting only acts as a limit. The current position of the screw is represented as a vertical line, which the profile passes through. From the graph, it can also be seen which stroke the screw passes through in the holding phase, or whether it “springs back.”

**Summary**

With an intuitive slider, the dynamics of the profile set by the machine operator can be adapted to the specific requirements of the particular application. The detailed view of the precalculated speed profile, as well as the actual values, means a higher information content and opens up greater potential for optimizing the injection profile. This ENGEL solution simplifies and speeds up the commissioning of new moulds.
Customer proximity. Customer satisfaction.

Global customer survey in September 2019

In 2017, the global customer survey provided us with valuable insight into our customers’ needs and their satisfaction. From this feedback we were able to develop and already implement a number of enhancements.

We regularly conduct the global customer survey to ensure that we continue to evolve in line with your needs. The next invitation to the online survey will be sent to you in September. Please take this opportunity to continue to share your candid opinion.

Your satisfaction is our incentive to become even better.