inject 4.0 – the answer for a smart factory
TechTalk on the challenges of the fourth industrial revolution and solutions which are already available today

Breathing exercises for process optimisation
iQ clamp control makes zero-fault production reachable

Secure connection
ARaymond trusts ENGEL victory machines for the production of quick connectors

The ENGEL HL Awards 2015
Hengst, Gardena and Schneegans receive awards for innovative applications on tie-bar-less machines

The Fakuma 2015 was a great success for ENGEL
Smart solutions for more efficiency, quality and flexibility
Looking ahead to the production of tomorrow with inject 4.0

Industry 4.0 provided a name for the digitalisation of our world. Although comprehensive networking, even with large quantities of data, is certainly technically feasible thanks to the highly dynamic developments in electronics, exponentially expanding complexity does confront users with major challenges. At the same time, entirely new concepts, business models, value creation processes and value chains are being created. Production has been linked to high standard services; companies are making use of more intelligent monitoring and decision-making processes to optimise and control entire value chains, almost in real time.

Demands on processing firms are increasing due to the desire of consumers for ever greater individuality in products created by means of highly flexible (mass) production. The answer to this is strongly networked systems, ideally with self-regulating processes.

This, in fact, was the path chosen many years ago by ENGEL in the field of injection moulding; it is not a new idea for ENGEL, but an ongoing development driven by the technologies available to us today. inject 4.0 is our umbrella term for ENGEL solutions and technologies. Many components play a part in bringing about flexible, self-optimising production. We organise the smart factory into smart machines, smart production and smart services. According to the specific task, modules make up solutions that combine to form the overall smart factory system.

The important point is to move beyond catchphrases and develop products and systems that generate real benefits for users under affordable conditions. However, we must not forget that a smart factory can only function effectively where products are consistently enhanced from a mechanical and application technology perspective and process technology can focus on innovative yet viable solutions.
ENGEL worldwide. around the corner.
Fairs, events, projects

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Smart solutions for more efficiency, quality and flexibility

inject 4.0 – the answer for a smart factory
TechTalk with Dr Stefan Engleider and Dr Gerhard Dimmler

Breathing exercises for process optimisation
iQ clamp control makes zero-fault production reachable

Power pack with a compact footprint
New ENGEL flexseal makes mass production economical

Successful ENGEL easix range gets bigger
New industrial robot types for the biggest injection moulding machines up to 55,000 kN clamping force

Faster positioning for shorter cycle times
Thanks to active vibration control, ENGEL viper robots also compensate for external oscillations

Collaborative research with ENGEL v-duo
ENGEL equips Open Hybrid LabFactory

Efficient and flexible integration of processes
ESS TEC invests for the future with ENGEL victory machines

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Automotive companies discuss local and international opportunities trend.scaut in Shanghai

Which direction is the automotive market in Asia moving in? What challenges are resulting from local requirements and international influences? What opportunities are being opened up by innovative manufacturing technologies? – These questions and others were at the focus of the trend.scaut international automotive conference that ENGEL hosted in October in Shanghai, China. More than 350 decision makers took part from all departments in plastics processing companies, from production and purchasing to design and development. ENGEL was able to attain recognised experts from well-known international and Chinese automobile manufacturers, OEMs, and tier-one and tier-two suppliers as speakers, for example from ExxonMobil, Porsche and PATA.

There is already a long tradition for the international automotive industry to come together every three years for exchanging ideas and networking at the event hosted by ENGEL. After holding some very successful events in Austria, ENGEL is now breaking new ground: for the first time, the trend.scaut took place in Asia.

Two additional events will follow in North America and Europe in 2016 and 2017. "The automotive industry is a very international industry, but each region still presents its own unique challenges for the producers and their suppliers," emphasises Franz Füreder, Vice President ENGEL automotive.

Welcome to the Jungle
15th Moulder’s Corner in Hagen

Around 500 plastics processors accepted ENGEL Deutschland’s invitation to the traditional exchange of information and experience in mid-September at their subsidiary in Hagen, Germany, and were astounded to encounter palm trees, hanging liana vines and tropical cocktails. "Welcome to the Jungle" – this was the motto of the 15th Moulder’s Corner. "The Moulder’s Corner is no ordinary industry event," says Rolf Saß, Managing Director of ENGEL Deutschland GmbH. "Many customers come every year because they appreciate the opportunity for professional exchange in an informal atmosphere and also enjoy the entertainment." Besides the show exhibits, the informative content was not neglected. Experts from ENGEL and the automotive industry presented innovative solutions. New technologies were demonstrated live in the Technology Centre.

"The mix of top-class speakers, innovative machine exhibits and a very friendly atmosphere makes the Moulder's Corner something special year after year."

Rolf Saß, Managing Director of ENGEL Deutschland

"The new structure of the ENGEL trend.scaut enables us to discuss the specific requirements of individual national markets even more effectively and thus further increase the practical benefits for attendees."

Franz Füreder, Vice President ENGEL automotive
Top performance at minimal costs
Plast Eurasia in Istanbul

Very short cycle times with maximum safety, while at the same time with very low investment costs – are the demands placed in her occupational category in this year’s competition for apprentices in the sector organised by the Economic Chamber for Upper Austria – she also won a special award for the best female trainee in a skilled technical trade. ENGEL apprentices also brought another trophy home to Schwertberg. Raphael Pechhacker secured second place in the machining technicians category. The ENGEL apprentices won against 805 participants from 123 businesses throughout Upper Austria.

The best female engineer is an ENGEL AUSTRIA employee. Budding design engineer Sara Brandstetter not only secured first place in her occupational category in this year’s competition for apprentices in the sector organised by the Economic Chamber for Upper Austria – she also won a special award for the best female trainee in a skilled technical trade. ENGEL apprentices also brought another trophy home to Schwertberg. Raphael Pechhacker secured second place in the machining technicians category. The ENGEL apprentices won against 805 participants from 123 businesses throughout Upper Austria.

The Austrian Economic Chamber grants apprentice awards

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ENGEL supplied the 1700-tonne press with a mould and integrated HP-RTM equipment. With a mould mounting surface of 2.2 by 1.8 metres, the machine provides the ability to produce a multitude of components using diverse materials and manufacturing processes. "We can use the ENGEL v-duo for processing thermoset moulding materials as well as for thermoplastic fibre-reinforced composites and HP-RTM processes," emphasises Prof. Ken Kendall, Professional Fellow at the WMG Automotive Composite Research Centre. "The precise control that this machine provides is essential for researching these processes."

"The flexibility that the ENGEL v-duo provides is very important for us as a partner in development for the automotive industry."

Prof. Ken Kendall, Professional Fellow at the WMG Automotive Composite Research Centre
Professional training programme gets started
ENGEL in the Czech Republic

Since September 1, 2015, the ENGEL component manufacturing facility at Kaplice in South Bohemia has become an educational institution. Seven young men and one woman are the first to receive their training as machine mechanics and metalwork technicians. The programme follows the Austrian dual education concept. For the practical training, ENGEL has built a new apprentice workshop.

Kaplice is home to the competence centre for sheetmetal processing for the worldwide ENGEL group. Currently employing 680 staff members, the operation is continuing to grow. "Finding qualified staff is difficult in many regions," as ENGEL CEO Dr Peter Neumann points out. "We are therefore investing strongly in our in-house training capacities. In the long term, this will be an important factor for success."

In the Austrian factories, the in-house professional training, with a retention rate of 98 percent, is already a decisive factor for securing skilled professionals. In Austria, ENGEL accepts 40 to 50 new apprentices to the programme every year. In 2012, Hagen in Germany was the first subsidiary to start its own training programme. In the spring of 2014, China followed. There are currently 32 apprentices at the plant for large-size machines in Shanghai.

Synergies for increasingly better medical care
Medical conference in Mirandola

Counting more than 100 participants, the medical engineering conference in Mirandola, Italy, was a great success. Together with its system partner A UNO TEC, ENGEL hosted the two-day event at the center of Europe's largest medical technologies cluster. Innovative technologies for manufacturing medical products were presented and current and future challenges were discussed. "Advances in medical care and treatment methods are continually posing greater challenges for manufacturing medical technology products. The demands on performance and growing functionalisation are leading to increasingly complex systems requiring the integration of diverse technologies," as Christoph Lhota, Vice President ENGEL medical, emphasised in his presentation. He went on to point out that only close interdisciplinary collaboration with partner enterprises along the value chain would make it possible to master these challenges.

Just how aptly the suppliers already follow this strategy and the synergies that emerge as a result were once again clearly demonstrated in Mirandola. Together with ENGEL and A UNO TEC, the companies Concept Laser, Moretto, Frigel and the mould manufacturer Eurostamp presented themselves not only in the lecture programme, but also with a joint exhibit. On an ENGEL victory injection moulding machine with an integrated robot, drip chambers for infusion therapy were fabricated in a live demonstration.

"In the future, we will only be able to continue providing solutions for the increasing needs of the patients if enterprises bundle their expertise along the value chain."

Christoph Lhota, Vice President ENGEL medical

Maximum quality, minimal unit costs
T-Plas in Bangkok

Thailand is one of the key markets among the emergent industrial countries in Southeast Asia. In order to meet the growing demands in the region more efficiently, ENGEL has been present with its own sales office in Bangkok since 2010 and opened a subsidiary there in 2013. "ENGEL is seen as a technology leader in this region," emphasises Aram Tongurai, the Managing Director of ENGEL Machinery (Thailand) Ltd. "With our extensive system solution, technology and automation expertise, we are able to give our customers an edge over their competitors at a time when quality and efficiency demands are increasing." At the T-Plas in August in Bangkok, ENGEL demonstrated how this can
be translated into practice with a sophisticated multi-component application. An ENGEL e-victory combi injection moulding machine with an ENGEL viper linear robot was used to produce sensor housings for flow metering with an integrated seal made of liquid silicone.

“Our integrated system solutions help our customers to manufacture competitively in the long term.”

Aram Tongurai, Managing Director of ENGEL Machinery (Thailand)

Maximising efficiency potential Andina-Pack in Bogotá

Together with its distribution partner Sinemco, ENGEL demonstrated an automated and fully integrated production solution for the fabrication of polypropylene stacking boxes on an ENGEL victory spex injection moulding machine with an ENGEL e-pic robot at the Andina-Pack in mid-November in Bogotá, Colombia. “In order to boost productivity, the packaging manufacturers in Colombia are relying increasingly on high-performance, energy-efficient injection moulding machines and automation,” says Dr Christoph Steger, Chief Sales Officer at ENGEL. The tie-barless clamping unit of the ENGEL victory injection moulding machine pulled almost all the stops for increased efficiency during the four days of the trade fair. It was the first time that the ENGEL e-pic, the most recent addition to the ENGEL robot family, was presented in South America.

Resource- and cost-efficient lightweight design MuCell seminar in Great Britain

More than 230 plastics processors visited the ENGEL UK technology centre in Warwick to learn about the possibilities and opportunities offered by MuCell foam injection moulding. Thus the two-day event, which was organised by ENGEL together with Jaguar Land Rover, became one of the best attended seminars on this topic in the global training programme offered by ENGEL. “MuCell offers the opportunity of combining resource-efficient lightweight design with a high degree of cost efficiency and excellent component properties,” as Graeme Herlihy, the CEO of ENGEL UK, points out. Under the ENGEL foammelt banner, ENGEL offers single source production cells for MuCell structural foam moulding. ENGEL imports Trexel MuCell systems from the USA for its customers, also managing the integration of the controls and safety aspects into the injection moulding machine and offering application-specific consulting, thereby making it particularly easy to implement the technology.

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The Fakuma 2015
was a great success for ENGEL

For ENGEL, the Fakuma 2015 was one of the most successful in recent years. Both the number of visitors at the stand and the project volume discussed at the trade fair are significantly higher than in the previous years. In 4.0 contributed significantly to this success. As Industry 4.0 has long become everyday practice lived out at ENGEL, the entire stand was designed as a smart factory. Visitors to the stand were impressed by the number and consistency of the products and services already available today that provide sustainable increases in productivity, availability, quality and flexibility for manufacturing processes and help prepare businesses to face the challenges of the future.

“The issue of Industry 4.0 is clearly more than just a buzzword; it is the megatrend among the plastics processors,” says Dr. Christoph Steger, Chief Sales Officer at ENGEL. “Many trade fair visitors took advantage of the chance to inform themselves at our stand about the possibilities for networking, systematic data utilization and the use of intelligent assistance systems in the context of our 4.0 solutions and to discuss their individual challenges and questions.”

Intelligent systems for greater quality and process capability
ENGEL presented both established and new solutions for the three core areas of a smart factory – smart machines, smart production and smart services. All manufacturing cells were linked with each other via ENGEL e-factory, the manufacturing execution system from ENGEL. In addition, the ENGEL e-connect customer portal on a central main computer provided an overview of the machine statuses and demonstrated how spare parts can be identified and ordered online during real-time operation. Intelligent assistance systems, that continuously and autonomously improve process capability and quality, were integrated into both the injection moulding machines and the robots. In this respect, in addition to iQ weight control, ENGEL presented two new products at the Fakuma 2015: iQ clamp control and active vibration control. (Read more about these innovations on page 12 and 16.)
Process integration ensures cost-effectiveness

In the area of process technology, ENGEL presented something special in Friedrichshafen for all five target industries: automotive, technical moulding, teletronics, medical and packaging.

Accordingly, at the Fakuma 2015, ENGEL sounded the starting gun for the first highly automated production of decor elements with the ENGEL clearmelt method. The manufacturing cell presented, consisting of an ENGEL duo combi M injection moulding machine and an ENGEL easix multi-axis robot, is intended for HIB Trim Part Solutions in Bruchsal, Germany. With this cell, the automotive supplier will produce decor elements with real wood veneer for automobile interiors. The ENGEL clearmelt technology combines back injection of inserts with polyurethane surface finishing and thus boosts efficiency significantly in comparison to conventional multiple-step production processes. Process integration was also the guiding theme in the teletronics part of the exhibition. On an ENGEL insert vertical machine, thermal switch housings were fabricated in a fully automated process. The raw material for the brass carrier plates was fed directly from a reel and pre-punched including creating a thread. The thread was tapped servo-electrically before the carrier plates – still on the line – were overmoulded with fibreglass filled polyamide. Quality inspections, including a 100% short-circuit test, were carried out directly after the injection moulding process during ongoing production. Eight ready-to-install parts left the production cell every 20 seconds. With this high degree of integration, the system solution implemented by ENGEL in collaboration with its partner MMS Modular Molding Systems guarantees the lowest possible unit costs and makes composite manufacturing economical even at locations with high wage levels.

Further highlights at the ENGEL stand include the fully automatic production of thermoplastic-silicone composite components that require no post-processing, the fabrication of needle holders for injection syringes in a consistently GMP-conforming manufacturing cell and the high-speed production of round containers with highly flexible IML automation.

An indicator for further positive development

"Process integration and automation continue to be among the most important motors driving innovation and growth," as Steger emphasises. "This is a worldwide trend, whereas Germany is one of the pioneers." The fact that processors around the world pay close attention to the innovative strength and experience of the technology companies in Western Europe is mirrored in the rising internationality among the visitors at the Fakuma. The very positive mood in Friedrichshafen is therefore an important indicator concerning the economic situation that can be expected in the coming year for the plastics industry, not just in Europe, but also beyond.
People everywhere are talking about Industry 4.0, the fourth industrial revolution. For some, everything seems to be 4.0; for others, this topic is just hype. Dr Engleder, what does Industry 4.0 mean to you?

ENGLEDER: Industry 4.0 is, above all, a tremendous opportunity that we want to take advantage of together with our customers. We feel very lucky to experience an industrial revolution and be involved in shaping it for our industry. Though, the word “evolution” would be a much better description of the changes that we are currently experiencing.

DIMMLER: This can be seen by the fact that Industry 4.0 is not a new idea for us and many of our customers, but is rather already long-established daily practice in many areas. What is new is that, under the inject 4.0 brand, ENGEL is bundling the products and services that are already available together with coming developments that help turn a manufacturing operation into a smart factory.

Dr Dimmler, what do you understand a “smart factory” to be?

DIMMLER: A smart factory means flexible, self-optimising production. It is only by utilising the full potential of the machines and other equipment in the manufacturing process that we can continue to boost productivity, availability, quality and flexibility. Precisely these elements are becoming increasingly decisive factors for securing competitiveness and future viability.

ENGLEDER: I am convinced that we will not be able to master the challenges of the future without Industry 4.0. Megatrends such as globalisation and urbanisation, the depletion of raw materials and energy sources, the lack of qualified staff and the loss of know-how are making it necessary for manufacturing processes to continuously become more efficient and easier to manage. Further effects include the fact that components are being designed to combine more and more functions, the demand for customisable products is increasing, and batch sizes are dropping. That is exactly what makes flexibility so important. In the three previous industrial revolutions, fabrication processes experienced substantial losses in terms of flexibility. In the smart factory, it is now again becoming possible – for the first time in 200 years – to manufacture with the flexibility of purely manual craftsmanship.

How will we achieve this?

ENGLEDER: The key lies in the networking and integration of production systems, the systematic utilisation of process and production data and the use of adaptive production systems.

DIMMLER: This can be easily understood when we look at how a smart factory is organised. We distinguish three different areas: smart machines that boost process capability and quality with self-adapting, decentralised assistance systems; smart production that ensures high productivity thanks to horizontal and vertical data integration; and smart services that improve
availability through close proximity and with the help of remote maintenance tools.

**Could you name some examples that are already available?**

**DIMMLER:** Let’s start with smart machines: with the help of the iQ software solutions, our injection moulding machines continuously analyse parameters relevant for productivity and quality, autonomously recognise deviations from the target specifications and automatically compensate for them during the ongoing process. The clever thing about this is that there is no need for the machine operator to acquire special skills for process optimisation; instead, this expertise is integrated into the control unit of the injection moulding machine which interacts with the operator.

**ENGLEDER:** In the smart production concept, the entire machine park is included in the focus. With ENGEL e-factory, ENGEL has its own MES (Manufacturing Execution System) in its portfolio that is specifically tailored for the requirements of the plastics processor and therefore achieves an extremely high level of vertical data integration all the way down to the level of individual cavities. It provides centralised access to all condition and process data and compares these with quality parameters.

**DIMMLER:** And finally, smart service encompasses both remote maintenance and preventive maintenance as well as our ENGEL e-connect customer portal. Here spare parts can be identified online, and service requests can be sent via smartphone. Further solutions are already in the pipeline that will help increase the availability of our machines.

**Networking and remote maintenance make it necessary for data to be exchanged between different production sites as well as between the processor and the supplier. It is exactly this aspect that causes headaches for many market participants.**

**How would you assess the issue of data security?**

**ENGLEDER:** Data security is definitely one of the challenges of Industry 4.0 that needs to be solved. But it is also important to know that not all Industry 4.0 tools require the exchange of data, and that we as the supplier do not have unrestricted access to our customers’ data. That is neither desired nor necessary. But for those areas where it makes sense, we need more than just mutual trust.

**DIMMLER:** Together with our fellow market players, we are also working intensively at the Euromap level to achieve uniform standards to significantly simplify both communication and data transfer and processing. What we are working towards is a common information model on the basis of the OPC UA architecture. This technology-neutral concept offers great possibilities for achieving standardisation. The communication between machines, peripheral components and sensors will also become more effective as the number of interfaces drops and as unified protocols become more widely used.

**What advice would you give injection moulders that are just getting started with Industry 4.0?**

**ENGLEDER:** Above all, we would encourage them, because there is no need to begin with a comprehensive solution. There will be many future challenges and solutions that we cannot even imagine today. The advantage of the evolutionary development is that each company can start, at any time, with a partial solution adapted to its own requirements and then gradually develop it further. Industry 4.0 will be different for each company. All in all, there is an enormous potential.
iQ clamp control: another step towards zero-fault production

Breathing exercises for process optimisation

Self adapting, decentralised assistance systems improve process capability and quality and are an important component in the smart factory, which is the focus of the ENGEL inject 4.0 programme. In the form of iQ clamp control, ENGEL is presenting a new software tool that automatically determines and adapts the optimum clamping force for each individual application based on mould breathing.

The iQ clamp control software is the second product in the iQ product family. The prefix "iQ" stands for "intelligent quality"; this means that expert knowledge is integrated into the injection moulding machine’s control unit. The iQ products assist the user with at least one of the following three factors:

- **Transparency** – with a clear-cut presentation of the parameters describing the process status
- **Assistance** – for example by automatically setting target values
- **Efficiency** – by improving productivity and reducing rejects, for example by automatically readjusting process parameters

It started with iQ weight control, which has established itself very successfully in the market with more than 700 installations in injection moulding machines with electrical injection units. With the help of the software, the control unit on the injection moulding machine regulates both the switchover point and injection profile in real time during the ongoing injection process, thus automatically compensating for fluctuations in the raw material and ambient conditions. When it was introduced to the market in 2012, this was a revolutionary innovation.

The focus of development for iQ clamp control was now on the clamping unit. By continuously adapting the clamping force, the software automatically keeps the mould breathing constant even under fluctuating process conditions.

**Automatically optimise clamping force**

During the injection process, the inflowing melt exerts pressure that pushes the two halves of the mould apart by a couple of thousandths or hundredths of a millimetre. This process is known as mould breathing. If the mould breathing is too great or too small, this can cause rejects due to flashes or burn marks (diesel effect). If the clamping force is too high, the mould is also subject to excessive stress and clamping force build-up unnecessarily consumes more energy.

...
While the clamping force is being built up, the mould height and the volume of the cavity are slightly reduced (middle). Part of this compression is compensated for by the opening pressure exerted by the melt during injection (bottom). The resulting change in the mould height is referred to as mould breathing.

Due to the opening pressure exerted by the melt, the clamping force increases during injection by a few kN compared with the reference curve (top). The difference between the clamping force curves and the spring stiffness of the overall system can be used to calculate mould breathing. The level of precision achieved is within a few tenths of a µm (bottom).

In order to optimise the clamping force manually, the mould breathing can be determined with the help of a gauge. This, however, is a subjective and imprecise approach. The measurement results are heavily dependent on the position of the gauge. In addition, it takes much experience to interpret them. Many injection moulders therefore work with the maximum clamping force available instead of adapting it to the respective process.

In order to keep efficiency potential that is relevant for competitiveness from being wasted, ENGEL has developed the iQ clamp control software that automatically determines and adapts the optimal clamping force on an objective basis. Thus the CC300 control unit for ENGEL injection moulding machines is capable of autonomously determining a process-relevant target value.

New process signal without additional hardware

Because mould breathing is caused by the pressure acting in the cavity, its curve is very similar to the curve of average cavity pressure calculated for the projected surface of the moulded part. The advantage over measuring the cavity pressure in the mould is the fact that there is no need to add extra sensors or expensive hardware. Development engineers at ENGEL have discovered a method for using the existing sensor system on the injection moulding machine to compute mould breathing during the ongoing process. To this end, the clamping system including the mould is conceived of as a spring, and the stiffness of the spring is determined during clamping force build-up. During injection, the tension in the spring increases slightly due to mould breathing so that the clamping force increases minimally compared with the set value. In order to determine this increase very precisely, dry cycles are performed at the start of production and the changes in clamping force are stored as reference curves.

In this way, iQ clamp control significantly reduces the risk of quality deficiencies, ensures optimal mould ventilation, protects the mould against overfilling and boosts energy efficiency.
The new ENGEL flexseal 300 T injection moulding machine sets new standards for the production of O-rings and flat gaskets.

Power pack with a compact footprint

O-rings and flat gaskets are essential to the reliability and safety of many different applications. In addition, standard mass-market products in particular are subject to exceptionally high pressure on pricing. These products can only be produced competitively with highly precise, reliable and efficient manufacturing technology. In order to provide even better support for its customers in this area, ENGEL has developed a new injection moulding machine for the processing of all common rubber compounds and other elastomer materials.

The new ENGEL flexseal 300 T horizontal machine with a clamping force of 3,000 kN has been designed specifically for the needs of international O-ring and flat gasket manufacturers and sets new standards for the industry with its features. Particular attention was given to the machine size during development, because the machine footprint is growing in importance as an efficiency factor and has already become a decisive criterion for choosing new production equipment. Thus the new machine is significantly shorter than other injection moulding machines for elastomer processing in this high clamping force class, and with its heating plates sized 550 x 650 mm still provides more room for the mould, for automation, and for accessing the machine nozzle.

As a standard, equipped for maximum energy efficiency

The hydraulic tie-bar machine is equipped with a screw injection unit that ensures very high precision for production with small and mid-sized shot volumes. The plasticising units for rubber, solid silicone, LSR and TPE can be exchanged very easily. Each injection unit is available in two cylinder diameters with up to 2400 bar injection pressure. In addition, numerous options are available such as custom-sized heating plates or a greater distance between plates.

Standardised interfaces are available for the integration of conventional brush and part removal modules as well as other automation features and peripherals. The peripheral systems can be operated comfortably via the CC300 control unit of the injection moulding machine.

As a standard, the ENGEL flexseal 300 T comes equipped with the servo-hydraulic ENGEL ecdrive. This helps reduce the energy consumption of the machine significantly because the heating phases in the production of O-rings and flat gaskets are often long.
Successful ENGEL easix range gets bigger

At Fakuma 2015, ENGEL presented its ENGEL easix multi-axis series of robots in a new dimension. Thanks to new models, even the largest injection moulding machines, up to 55,000 kN clamping force, can now be automated with a consistent ENGEL solution using multi-axis robots.

The new large ENGEL easix robots expand the range of industrial robots for use with large-size machines. Thanks to a reach extending to 3900 mm and a load capacity of up to 240 kg, the robots are used in the production of bumpers, instrument panels and waste containers, among other things. Kuka, with headquarters in Augsburg, Germany, is the cooperation partner for the expansion of the model series. For the smaller models, ENGEL is continuing the successful collaboration with Stäubli Robotics in Bayreuth, Germany. Since being introduced to the market in 2010, the ENGEL easix robots established themselves very well in quite diverse applications – even in cleanrooms.

Consistent operating logic for more convenience, security and efficiency

The controls for the ENGEL easix robots are fully and seamlessly integrated into the control unit of the ENGEL injection moulding machines, and that is the distinct advantage of the ENGEL solution. Plastics processors profit from a consistent logic for the injection moulding machine and the automation solution. It makes no difference for the control unit whether it actuates the X, Y and Z axes of an ENGEL viper linear robot or the six rotary axes of an ENGEL easix industrial robot. The additional movement instructions for the multiple-axis robot integrate seamlessly with the graphical user interface on the control unit, thus simplifying the operation of the multi-axis robot considerably. To allow for simple and fast parameterisation despite the complexity of the overall system, the control unit provides different user levels, from a simple view to a fully object-oriented visualisation of the sequence. Many tasks that previously required calling in a programmer can now be managed by the machine operators themselves, such as synchronisation of the robot movements with the ejectors. As a result, both the availability of the manufacturing cell and productivity are increased. Further benefits include a higher level of process reliability and production efficiency. Not only do machine and robot merge to become one unit, but also peripheral equipment like conveyor systems, laser units or optical systems. In this way, all components of the manufacturing cell access a common database and can coordinate their movement sequences and feedback loops automatically to achieve maximum overall efficiency.
In mobile phones, 3D motion sensors have long become standard equipment. Now the ENGEL viper robots also use this technology. To date, the robots own expected oscillations were calculated for vibration control. Now, external influences can also be compensated for online, which allows the robots to make a contribution to help the injection moulding process continuously optimise itself and make production smarter in the sense of Industry 4.0. Thanks to the active vibration control, the ENGEL viper robots reach a stable working position more quickly and operate with significantly greater positioning accuracy, which is important for such tasks as placing insert pieces or transferring pre-moulded parts.

Perfect synchronisation of far more than twelve axes
An ENGEL viper 40 double robot gave an impressive demonstration of this at Fakuma. The respective grippers held a sleeve and a corresponding core. The two robots with a common Z-axis rotate the two parts together, inserting one inside the other and separating them again multiple times within a very short time, without the sleeve and core touching each other. In addition to the active vibration compensation, another advantage of the ENGEL viper robots came into play: the perfect synchronisation of independent movements. During the exhibition, a total of twelve axes were controlled synchronously – which is far from exhausting all the possibilities.

All ENGEL viper robots will be equipped with active vibration control from size 20 up to the largest ENGEL viper 120 robots with a load capacity of 120 kilograms. The ENGEL viper 40 and 60 robots will make the start.

New drive package for more efficient dynamics
In revising its linear robot series, ENGEL has also boosted the overall performance. A new multidynamic drive package ensures that the robots automatically adapt their dynamics to the real weight load. The efficiency control function also takes the cycle of the injection moulding process into account. Within only three cycles, the ENGEL viper achieves the optimal dynamics for the respective injection moulding process, for example by reducing its own speed corresponding to a long cooling stage without increasing the overall removal time. All these measures make significant contributions that reduce overall cycle times and boost energy efficiency. Beyond that, the mechanical components are given the best possible protection against wear, making longer maintenance intervals possible and yet still ensuring long lifetimes.
Collaborative research with ENGEL v-duo

An ENGEL v-duo 3600 machine will be installed in the new Open Hybrid LabFactory in Wolfsburg, Germany, to support research into functionally integrated composite technologies. ENGEL is a founding member and sponsor of the research centre initiated by Volkswagen in 2012.

To cover the entire value chain for lightweight hybrid components, from concept and design to production and recycling, the Open Hybrid LabFactory association oversees every step in the process in partnership with international technology leaders – including ENGEL AUSTRIA. The aim of such wide-ranging collaborative research is to unlock previously inaccessible potential in both market development and technology while speeding up the application of innovative lightweight construction technologies in the mass production of automobiles. With this in mind, the association has defined a number of research projects. Amongst other things, the new ENGEL machine is intended for the ProVorPlus project that focuses on functionally integrated process technologies for the pre-assembly of fibre-reinforced plastic/metal hybrids.

In its own Center for Lightweight Composite Technologies in Austria, ENGEL also deals intensively with innovative technologies for lightweight automotive construction. In collaboration with its partners, ENGEL has established a number of key milestones over recent years. "One important precondition for successful FRP projects is that the enterprises bundle their expertise along the value chain," stresses Peter Egger, Director of ENGEL Center for Lightweight Composite Technologies. "That belief underpins our commitment to the Open Hybrid LabFactory."

Proven in practice

ENGEL developed its ENGEL v-duo series specifically for fibre-reinforced processing. In contrast to the presses conventionally used in such applications, the vertical ENGEL machines have a relatively small footprint. The clamping unit can be accessed from all four sides instead of just two. Thanks to very high rigidity and the outstanding parallelism of the mould mounting platens, it guarantees the precision casting of even fine structures. Since the ENGEL v-duo operates without a hydraulic accumulator and instead works with the servohydraulic ENGEL ecodrive as standard, the machine is also setting new standards of energy efficiency in the field of fibre-reinforced processing.

"Composite engineering needs 'composite' development. That belief underpins our commitment to the Open Hybrid LabFactory."

Peter Egger, Director of ENGEL Center for Lightweight Composite Technologies
As a subcontractor, we have to be able to predict the future," says Elliot Essenburg, Engineering Coordinator of ESS TEC. It is this foresight that, in combination with decades of injection moulding experience and a strong passion for polymeric materials, secures a decisive competitive advantage for the privately owned company. In order to be prepared when the first enquiries come in, investments in new technologies are made at an early stage. "When our customers have a new product idea, they get the mould in six to eight weeks. We can't plan and procure a new production cell within that time," says Essenburg. Therefore, the company's newest injection moulding machine, a two-shot ENGEL victory 85 US, is equipped with a rotary table and an integrated ENGEL easix multi-axis robot even though, at this time, there are no applications that require the rotary table. One of the parts the new manufacturing cell is being used to produce is back-lit control panel buttons. Using a 6+6 cavity mould, the first step is the processing of white polycarbonate, which is then partially overmoulded with black PC-ABS in the second set of cavities. Upon mould opening, the multi-axis robot removes the six finished parts, while transferring the pre-moulded parts to the second set of cavities. "The transfer technique is still dominant in multi-component injection moulding," explains Josh Fredenburg, automation expert at ESS TEC. "But I am convinced that we will need the rotary table very soon."

Small machines for low unit costs
An instinct for emerging trends and lucrative niches is a recurring theme throughout the history of ESS TEC. When ENGEL was the first injection moulding machine manufacturer worldwide to present a machine with a tie-bar-less clamping unit more than 25 years ago, they were the first customer in the USA to support the completely new design principle. "We quickly realised,
back then, that we could secure a competitive edge for our company with the tie-bar-less machines,” says Larry Essenburg, Elliot’s father and founder of the company. “Small moulds on large machines – that was the standard, and suddenly we were doing just the opposite. Our customers were quickly convinced of the benefits, as that is precisely where the key lies to lower unit costs.”

More than 20 years of successful collaboration: Elliot Essenburg, James Davis and Larry Essenburg of ESS TEC, Steve Belrose of ENGEL distribution partner A.L. Belrose in Grand Rapids, MI, Larry Alvey of ENGEL Machinery in York, PA, and Franz Presl of ENGEL AUSTRIA (from left to right).

A second piece to keeping unit costs low is avoiding rejects, which can be accomplished through use of a highly precise clamping unit. With the tie-bar-less machine, the flexible central element is the design component that is responsible for this. It makes it possible for the moving platen to follow the mould precisely while building up clamp force. To achieve this, the platen lifts itself from the linear bearing and automatically aligns itself to the stationary platen. In addition, the patented force divider ensures that the clamping force is distributed evenly across the entire cross-section of the mould. “When the mould is mounted correctly, there is an absolutely constant compression,” says Larry Alvey, Business Unit Manager Automotive at ENGEL Machinery in York, PA. “That way we ensure a very consistent part quality and a very high level of mould protection.”

For the two-component control panel buttons, a clean parting plane is particularly important. Some of the numbers and symbols that are to be back-lit measure only a few millimetres. “Sometimes we produce a better quality part than our customer does using the same mould on a machine with tie bars,” says Larry Essenburg. “Last month we had a reject rate of 74 ppm for the whole company. That is practically nothing.”

Precise movements in a very small space
Currently, the machine park in Holland includes 21 tie-bar-less injection moulding machines, with clamping forces that range from 35 to 240 tons. ESS TEC has specialised in small components. The maximum shot weight processed is 16 ounces, about 450 g. ESS TEC also profits from the barrier-free access to the mould area during machine set-ups, which are changed up to nine times a day. “The moulds can be mounted and dismounted significantly faster than if we had to heave them over tie bars,” says James Davis, Vice President of ESS TEC. “We don’t need to worry about whether the moulds will fit between the tie bars, and instead, with consideration for achieving maximum overall efficiency, we can select the machine according to the required clamping force.”

Likewise, the robot can access the cavities directly from the side and therefore operate safely within a small space. The ENGEL easix is the first multi-axis robot at ESS TEC. “With it, we can work with extreme precision,” emphasises Josh Fredenburg. “Small parts will not tolerate even the smallest inaccuracy.” In addition, the multi-axis robot provides a lot of flexibility for the future as the number of multi-component processes continues to grow.

This ENGEL victory 85 US was delivered including a rotary table and an ENGEL easix multi-axis robot, ensuring it is optimally equipped for future multi-component applications.
Mountings and connectors for fuel-carrying systems in the power train are safety-relevant components that demand utmost precision. In order to produce them with utmost efficiency, the automobile supplier ARaymond trusts tie-bar-less injection moulding machines from ENGEL.

With 22 production facilities worldwide and more than 5,400 employees, ARaymond is one of the big players in the automobile industry and yet has remained a family-run business, currently in the hands of the fifth generation. Founded in 1865 by Albert-Pierre Raymond in Grenoble in the French Alps, ARaymond at first produced fasteners for shoes and gloves, developed the globally successful snap fastener a few years later, and laid the foundation for continuous growth in the 1940s by focussing on the new material called plastic and establishing an automotive business unit.

From the production plant in St. Egrève to the North of Grenoble, they deliver automobile manufacturers like Peugeot or Citroen, OEMs and smaller suppliers that have specialised in fluid systems. The location is home to two product families: fastening solutions and quick connectors. Very diverse specifications in individual countries means that a great variety at products must be produced.

Innovative strength and flexibility have always been lived out in daily practice at ARaymond. When ENGEL became the first company worldwide to bring injection moulding machines with a tie-bar-less clamping unit onto the market, ARaymond was soon among the first using it in France. "Back then we started with the production of quick connectors and invested in a tie-bar-less machine specifically for these new products," says Boris Jacquet, production manager for injection moulding and assembly in St. Egrève. "The development of this product family is closely tied to the development of the tie-bar-less injection moulding machines. The quick connectors are virtually predestined for this type of machine."

Fast mould set-up is a key to high productivity

Because of the many movable elements, the moulds for producing the quick connectors are particularly large and unwieldy in construction, while the clamping force required to form the rather small parts is comparatively low. "We can often recommend a smaller injection moulding machine with one or even two times less clamping force because the mould has room to completely fill out the surfaces of the mounting platens.
all the way to the edges," explains Philippe Sterna, managing director at ENGEL FRANCE located in Wis-
sous. "Our customers therefore save investment and
operating costs and can also keep production cells
compact in size."

The moulds for quick connectors have up to 32 cavities.
The number of cavities decreases with the increasing
complexity of the component being produced. Also
large moulds can be fitted on the tie-bar-less machines
without having to remove the core-pulls. "In order not
to lose any production time due to mould set-up, we
connect all the lines for the cooling system before it is
brought into place in the mould area," says Jacquet.
"If the clamping unit had tie-bars, that would not be
possible."

**Maximum precision in both the injection
and clamping unit**

Five production areas are dedicated to these two pro-
duct families at this production site. Half of the injection
moulding machines are from ENGEL, and of those, 90
percent are tie-bar-less. The ENGEL e-victory has been
predominant in the most recent orders. "The production
of the quick connectors in particular requires a very high
degree of precision," explains Jacquet. "The specifi-
cations allow a tolerance of 0.05 mm, and beyond that,
burr is absolutely unacceptable in safety-relevant
components. With the combination of an electric injec-
tion unit and a servo-hydraulic clamping unit, we can
ensure that these requirements are fulfilled."

Two factors in particular are responsible for the high
precision of the clamping unit. One is the ENGEL servo-
hydraulic ecodrive, and the second is the high paral-
lelism of the mould mounting platens. For ARaymond,
it is not an option to switch to all-electric machines for
this product family. "We analyse the life-cycle costs
for each application," says Boris Jacquet. "Hybrid

**An idea-workshop for increased competitiveness**

Twice a year, the production management team from
ARaymond and the experts from ENGEL meet to
analyse the efficiency of the machine park, present
new developments and discuss trends. "In order to
maintain and increase our competitive edge, we must
keep our finger on the pulse of the times," says Boris
Jacquet. Industry 4.0 – this is one of the current
challenges that ARaymond and ENGEL are tackling
together. The newer ENGEL machines in St. Egrève
are interconnected via ENGEL e-factory.

The managing director of ENGEL FRANCE and the
production manager of ARaymond have been wor-
king together in this way for 15 years. Both family-
run companies have in common the fact that there is
hardly any fluctuation at the decision-making level. The
longstanding connection is another factor for success.

*These quick connectors are deployed in the fuel carrying systems in
car and truck power trains.*

For more than 20 years, tie-bar-less injection moulding machines have been providing utmost productivity, economy, and flexibility at ARaymond.
The ENGEL HL Awards 2015

ENGEL’s tie-bar-less technology promotes design freedom, efficient processing methods, compact production cells and creative process ideas. ENGEL periodically honours outstanding applications with the ENGEL HL Award. Three companies were honoured at the design centre in Linz on the evening of June 16th during the 2015 ENGEL Symposium. The 2015 HL Awards went to Hengst Automotive, Gardena and Schneegans.

It was the eighth time ENGEL recognised applications that make excellent use of the advantages of ENGEL’s injection moulding machines with tie-bar-less clamping units. For the first time, the prizes were awarded in three categories: “Efficient use of the mould area”, “Innovative process integration” and “Economical automation concept”. 27 applications from 14 countries applied for the internationally coveted distinction this year. All the applications submitted were scrutinised closely. The jury traditionally consists of three representatives from the areas of university research, industry and the trade press. The 2015 panel included Prof. Dr Frank Ehrig, director of the Institute for Material Engineering and Plastics Processing (IWK) at the University of Applied Sciences Rapperswil in Switzerland, Gunnar Hack, managing director of Hack Formenbau in Kirchheim unter Teck, Germany, and Harald Wollstadt, editor-in-chief of the trade magazine Plastverarbeiter, which is published by Hüthig in Heidelberg.

Hengst in the category “Optimal use of the tie-bar-less mould area”
The replacement of metals with plastics is progressing rapidly, and this includes components under car bonnets. Hengst SE & Co. KG, which is headquartered in

And the winner is ...
Münster, Germany, has developed a solution made from polyamide reinforced with glass fibre for fabricating oil filter module bases that are used in various Audi and Volkswagen four-cylinder diesel engines. The single-cavity mould has eight core pulls altogether, which account for its considerable size. The bases are made on an ENGEL victory 3550/450 tech injection moulding machine with a clamping force of 4,500 kN. Alternative offers based on injection moulding machines with tie bars began at a clamping force of 8,000 kN. The tie-bar-less machine enabled Hengst to reduce the investment costs for the application considerably and to keep the production cell compact.

Gardena in the category “Innovative process integration”

At 20 million units per year, connectors for garden hoses are the components with the highest production volume at Gardena Manufacturing GmbH in the southern German municipality of Gerstetten, a company of the Husqvarna Group. Since January of this year, an ENGEL victory 740H/310W/400 WP combi injection moulding machine has been used to mould them. The integrated ENGEL easix multi-axis robot removes 16 hose connectors from the machine every 16 seconds. In order to be able to process the thermoplastic housing material and the elastomer for the grip surfaces simultaneously, the rotary mould has two sets of 16 cavities and four sets of 16 cores. The process has an ingenious twist: after the thermoplastic components have been injection moulded, the mould then turns the cores so that they are in a cooling position before overmoulding the soft components in a third step. This prevents the cooling from extending the cycle time.

The four sets of 16 cores are each arranged in linear fashion. The heart of the tie-bar-less clamping unit, the force divider, plays an especially important role in ensuring the connectors produced in the cavities at the top and the bottom have exactly the same wall thickness as those produced in the middle cavities. The jury was won over by the high precision and process consistency levels, achieved despite the unconventional arrangement of the cavities, made possible by the even distribution of the clamping force through the force divider.

Schneegans in the category “Economical automation concept”

Space is very limited under a car bonnet. Like a big 3D puzzle, the various components needed to make the car run all have to fit together neatly. The best example of this is the oil level measurement modules.

So that they fit into the space provided in the best possible way, they are no longer made of steel but completely of plastic. Schneegans Freudenberg Silicon GmbH uses projectile injection technology (PIT) to produce more than 3 million modules every year in Losenstein, Austria. Every 45 to 50 seconds, two completely assembled units are ejected from a fully automated production cell, the core of which is a tie-bar-less ENGEL victory 400 tech injection moulding machine. Four integrated multi-axis robots share the tasks of inserting the projectiles, removing the moulded parts from the mould, detaching the overflow cavities, printing on the front of the funnels, fitting O-rings, assembling oil sleeves and dipsticks, leak testing and packaging the finished modules. As space is not just of particular importance under the bonnet, but also in Schneegans’s production hall, a tie-bar-less solution was always going to have to be used for producing the modules. It allows the multi-axis robot supporting the injection moulding process to work especially close to the clamping unit and access the cavities without losing any time.

Other innovative applications on the shortlists

In addition to the winners, ENGEL has announced the names of the other applications that made the shortlists for each category. Gustav Hensel (Lennestadt, Germany) and UAMT (Oradea, Romania) completed the “Efficient use of the mould area” list. In the “Innovative process integration” category, the shortlist places were taken by Valeo Autoklimatizace (Rakovnik, Czech Republic) and Tente-Rollen (Wermelskirchen, Germany). And in the “Economical automation concept” category, Mora (Mora, Sweden) and Weidplas (Rapperswil, Switzerland) were the best-placed candidates behind the winner.
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