

# automotive

Powerful, innovative injection moulding solutions



**ENGEL**  
be the first



## Expertise & advancement as standard

In automotive engineering, plastics are increasingly becoming the dominant material – ENGEL supplies complete solutions for injection moulding production from a single source. As a long-standing technology partner to the automotive industry and its suppliers, we know what is important: we offer long-standing expertise, comprehensive development competence and reliable machine technology. Produce in the fast lane – and set new standards in terms of safety, functionality and design.



## Customised solutions For all areas of the automotive industry

We offer you unsurpassed comfort and safety.

Many parts of a passenger car's or commercial vehicle's exterior, interior, safety and control technology or drive train can only be manufactured using injection moulding. ENGEL enables components of the highest quality: with our manufacturing solutions, we support you in making passenger vehicles and commercial vehicles even more comfortable, safer, more cost-effective, more intelligent and more environmentally friendly.

We are happy to move forward with you.

With smart products from our inject 4.0 program, we accompany you step by step on your way to digital and networked injection moulding production: you benefit from greater transparency, required to meet the strict documentation requirements, intelligent assistance and increased efficiency throughout the entire production process.

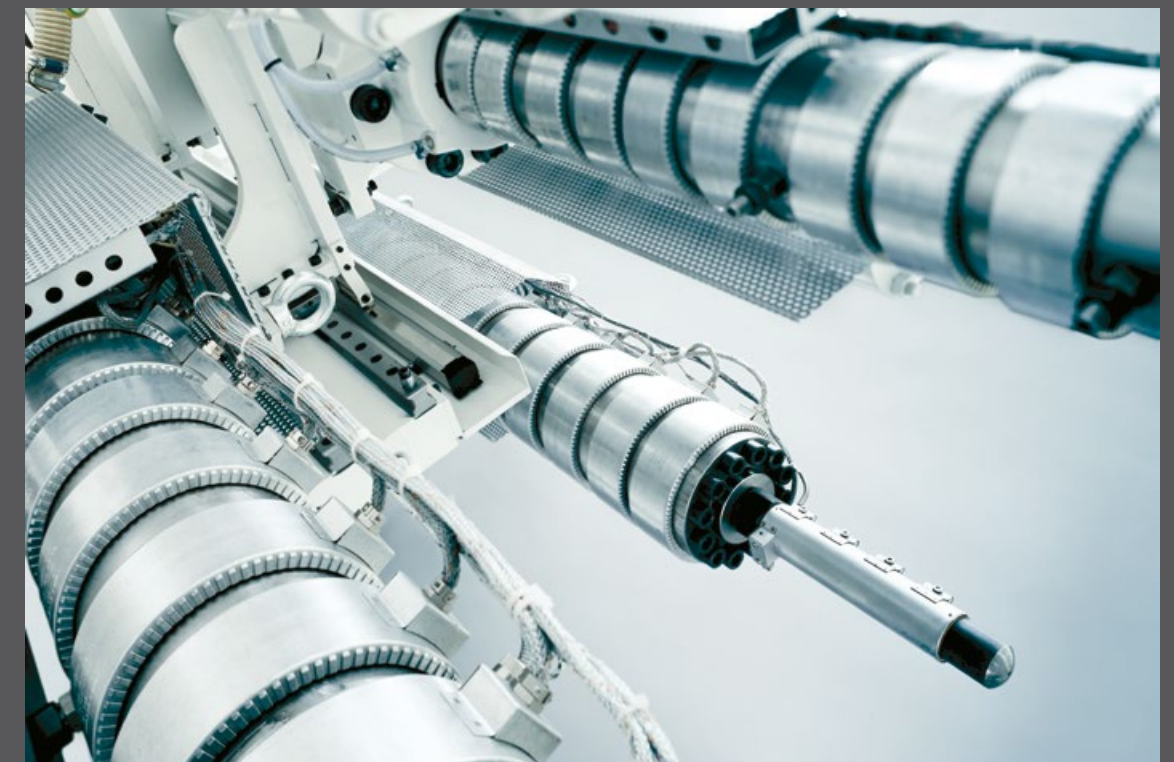
We deliver everything from a single source.

As a provider of complete solutions, we are the ideal partner for complex, highly integrated production cells: our injection moulding machines, technologies and automation technology can be perfectly meshed. We accompany you from the concept phase through to implementation and beyond that with comprehensive services, consulting and training.

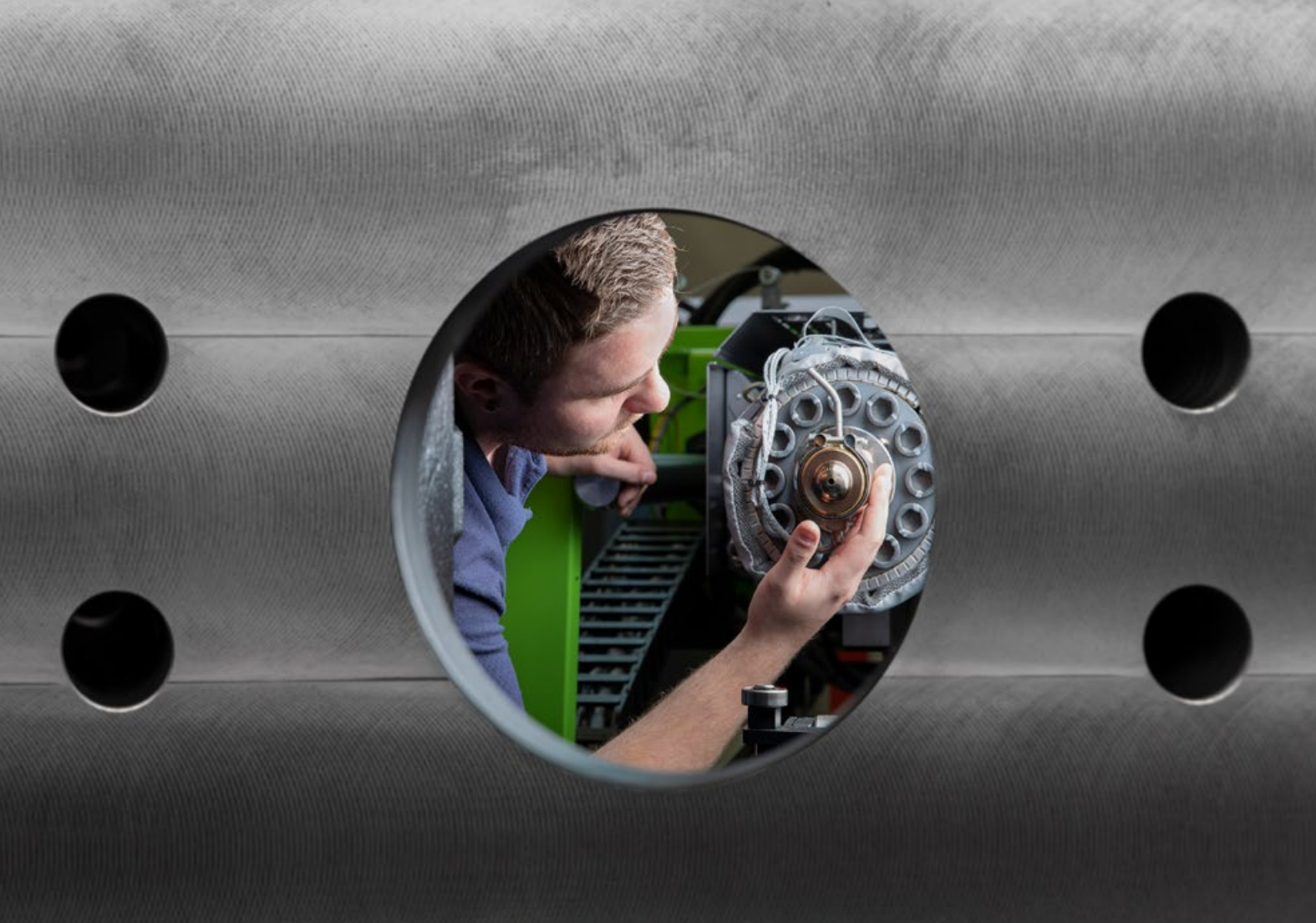


## Innovative injection moulding technologies For diverse applications

Special injection moulding processes are indispensable, especially in automobile production. Nowhere else so many technologies are in demand to produce multi-component or particularly lightweight parts, to decorate and coat surfaces and to integrate a wide variety of features into a element.







#### **ENGEL combimelt**

Multicolour and multi-component injection moulding of tail lights, control trims and labelled buttons, as well as rigid-soft connections for special haptic features or sealing functions.

#### **ENGEL clearmelt**

Scratch-proof, high-quality surfaces combined with 3-D effects are exceptionally attractive. Thanks to ENGEL's innovative clearmelt method, decorative parts with these characteristics can now be produced in a time-saving, cost-effective and highly productive manner. Using multi-component technology, a thermoplastic carrier is flood-coated with transparent polyurethane.

#### **ENGEL elast/LIM & Duroplast BMC**

Important applications for classic elastomers in the automobile are the engine and body supports, seals for window glass, media lines, electrical systems and bellows. Insulation and sealing components for electrical connectors as well as sealing rings and sealing diaphragms made of LSR offer especially high resistance against heat and cold, excellent ageing performance and very good resistance against weather. The exceptional aging and UV resistance also makes LSR particularly interesting for optical applications.

ENGEL offers a complete range of vertical and horizontal injection moulding machines for processing elastomers. Plasticising units for processing strip rubber compounds based on the first-in first-out principle are available from ENGEL. ENGEL LIM stands for screw or piston plasticising units, as well as plasticising and conveying technologies for liquid silicone rubber.

Thermosets are used wherever parts are exposed to the highest mechanical stresses. ENGEL's Duroplast BMC technology supplies high wear-resistant systems to efficiently produce these demanding materials.

#### **ENGEL foammelt (MuCell® and processing of chemical blowing agents)**

ENGEL foammelt – structural foam moulding of housings and interior parts for the lowest possible weight and the best properties by foaming the plastic in the mould

#### **ENGEL foilmelt**

Individual surface design and functional integration with capacitive and coated films for vehicle interior parts can be achieved by back injecting multi-layer composite films that look like metallic paint, aluminium or chameleon designs or holograms.

#### **ENGEL glazemelt**

Injection-compression moulding of transparent panes with low internal stress, using integrated mounting elements and sealing functions on the ENGEL duo combi M large-scale, dual-platen machine.

#### **ENGEL insert**

Overmoulding of metal and glass to create connectors, switches and sensors, fuel system elements, electrical and electronic components and glazing elements in vertical injection moulding machines and moulds with a horizontal parting line.

#### **ENGEL organomelt**

A revolution in Lightweighting: this technology replaces steel and aluminium sheet with thin, yet strong organic sheets, not only saving weight in automobile manufacturing but also great performance with corrosion resistance and increased freedom of design.

#### **ENGEL tecomelt**

Production of textile-decorated vehicle interior parts using injection moulding or forming on injection moulding machines with a horizontal or vertical clamping unit.

#### **ENGEL gasmelt/watermelt**

The perfect option when it comes to moulding hollow parts, complex tube structures or avoiding shrinkage. Available with gas or water as the pressure medium.

#### **ENGEL optimelt**

Optimised plasticising systems and system solutions with single or multi-colour injection moulding and injection-compression moulding solutions for the efficient production of high-quality lenses.

## Structural and exterior parts

### Attractive, protective

First impressions are critical – this is particularly true for automobiles. The design freedom of plastic is used more and more to individually design the outer surface of vehicles. Injection-moulded exterior parts are very demanding in terms of surface and dimensional stability. ENGEL injection moulding machines and technologies ensure the best surface quality and finest cost effectiveness, even for large moulded parts and long flow paths.



## Strong in light-weight construction

As an alternative to metal structures, light-weight elements made of long glass fibre-reinforced thermoplastics, for example, have gained importance. Today, they can be customised, designed to suit the application and safely injection-moulded using state-of-the-art plasticising components. The innovative ENGEL organomelt composite technology sets a new milestone in weight reduction, replacing steel and aluminium sheet with thin but strong organic sheets.

## Large-scale exterior parts

High-performance screws ensure high plasticising capacity. This is of great importance, for example, in the production of bumpers. Hydraulic or electrical screw drives, that can work in sync with the mould movements, reduce the cycle time and increase output and cost effectiveness. Special screws ensure minimal wear and a long service life despite the high loads produced by high-performance plasticising.

### Automation of secondary operations

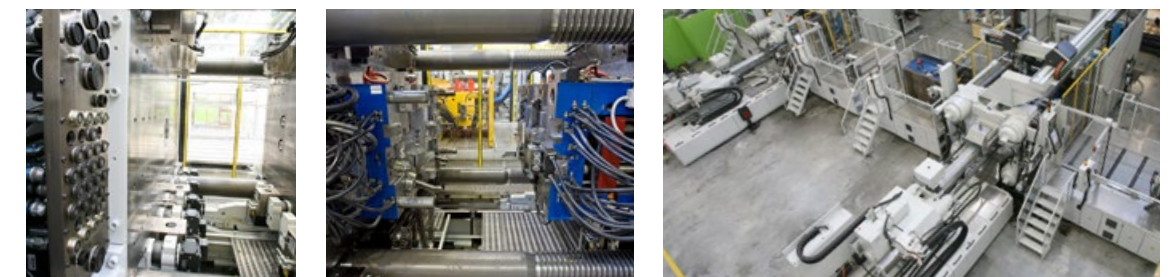
Customer- and application-specific automation of the injection moulding machine increases the cost effectiveness of the overall system when coating-friendly bumpers and other exterior parts are produced. Automation includes sprue cutting, flaming to activate the surface, deburring, quality inspection and depositing the part.

### Injection-compression moulding for greater quality

When injection moulding large exterior parts with long flow paths, and large flow path to wall thickness ratios, injection-compression moulding is recommended to safely fill the moulded part, cleanly mould the surface and avoid internal stress. Injection-compression moulding creates high precision parts with great cost effectiveness.

### Empowering autonomous driving

The ENGEL clearmelt and foilmelt technologies, and our solutions for PC processing, enable parts with electromagnetic transparency which are essential for autonomous driving.



The integrated ENGEL famox (fast mould exchange) mould changing system reduces setup times, while improving machine flexibility and increasing capacity utilisation.



## Wheelhousing liners

Wheelhousing liners and cover strips in the engine compartment need noise-reducing properties. These are achieved by injection moulding specifically modified polymers or by overmoulding textile materials. By combining the ENGEL combimelt multi-component technology and the ENGEL tecomelt back injection technology in a single injection moulding machine, noise-optimised products are created in one operation which can be fully adapted to customer requirements in terms of geometry, fasteners and acoustic properties.

## A-, B-, C- and D-pillars

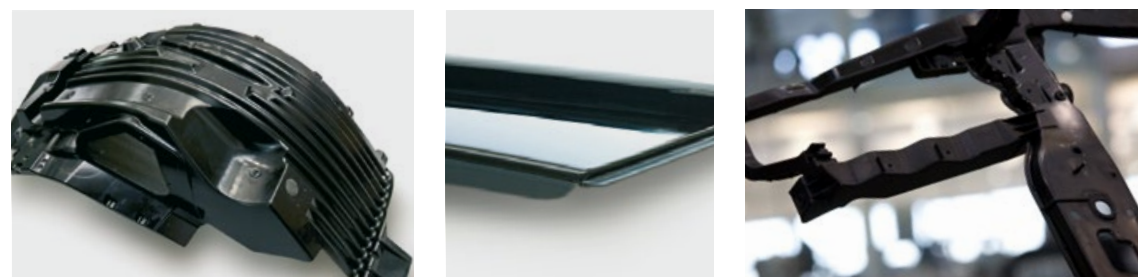
The ENGEL combimelt multi-component method integrates mounting, optical and sealing elements in a single step, eliminating sink marks and ensuring the best possible surface quality. Pillar elements with high impact strength can be fully overmoulded with a second plastic in order to attain highly reflective surfaces. Furthermore, an additional TPE component seals the chassis and absorbs vibrations.

## Front-end carrier made of LGF plastics

Single-screw systems for long glass fibre-reinforced (LGF) pellets enable processing on standard injection machines. Optimised plasticising units on the ENGEL duo large-scale machine can produce structural elements with a high load-bearing capacity while keeping capital expenditure for the production technology low. Melt preparation with optimised screw unit geometries reduces the shear load of the material, providing optimum blending of the long reinforced fibres in the polymer.

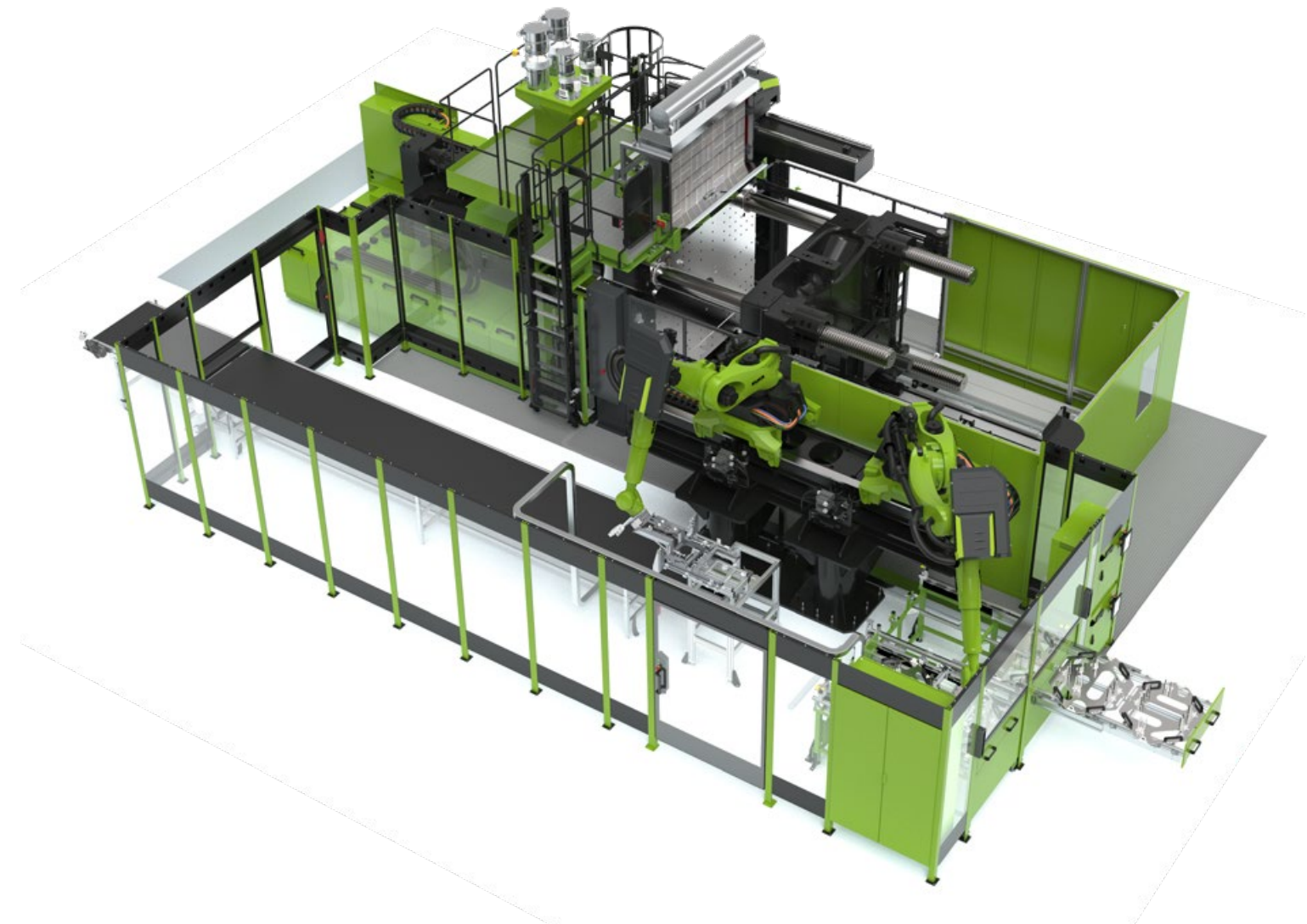
## Structural elements with hybrid technology

In hybrid technology, a sheet is inserted into the mould and overmoulded with plastic to reinforce it. ENGEL offers special automation solutions for inserting and removing the sheets. The highly precise, intuitive mould protection detects deviations on the inserted part, providing the highest level of protection against mould damage and ensuring the operational safety and availability of the entire system.



## Brake pedals

ENGEL organomelt replaces steel and aluminium sheet with thin but strong organic sheets which can be used, for example, in the manufacturing of brake pedals. This results in a considerably lower weight compared to conventional solutions. At the same time, organic sheets are characterised by high strength and rigidity.



# Glazing and light engineering

## Transparent, coloured or luminous

Windows, covers and lenses made of transparent plastics (PMMA, LSR, polycarbonate) are lightweight and offer designers a great deal of freedom. Today, complete glazing systems of plastic combine numerous features with lower system costs.



### The right technologies

Plastic has special potential in lighting technology: the classic multicolour technique is enhanced using state-of-the-art LED technology and integrated sealing functions. More and more, optical and glazed parts in automobiles are being made of transparent plastics instead of glass. On the one hand, injection-moulded plastic parts offer more design flexibility; on the other, they are significantly lighter, reducing the vehicles' fuel consumption and CO2 emissions.

### Clean production

Increasing expectations towards glazing and light engineering are also raising the bar for production technology and the production environment. Many glazing elements are injection-moulded and processed further in a cleanroom environment. Machine technology solutions, such as non-guided tie-bars on ENGEL injection moulding machines ensure the lowest possible soiling tendency.

### NO tie-bars – unrestricted access

The ENGEL victory machine saves valuable cleanroom space – for example in the production of headlamps with diffusing lens. Thanks to the unique tie-bar-less technology, it is not necessary to “work around” the tie-bars in a time-consuming manner. This means that robots can pick up parts quickly and without obstructions, while moulds can be changed from the side to save space.

## Glazing using plastic

Specific equipment for the injection moulding of glazing elements is available for the ENGEL duo dual-platen, large-scale machine. The BASIS, PROFI and EXPERT packages include special high-precision injection-compression programs that enable injection moulding of large-scale parts under low stress while keeping the optical properties constant over the entire surface of the moulded part.

### Compact machines for large parts

Compared to standard two-component machines, the machine design of an ENGEL duo combi M with horizontal rotary table reduces the required clamping force and the capital expenditure for engineering. Moreover, the injection units are located at the centre of the machine axis opposed to each other, which facilitates clamping force control and process control. This results in the largest possible parts relative to the size of the clamping unit.

### Gentle plasticising

In order to ensure that moulded parts of transparent plastics such as PMMA and PC always have the highest optical quality, ENGEL offers screws with special geometries and non-return valves.

### Integration of decorative and functional elements

ENGEL foilmelt in-mould decoration allows to integrate functional elements, such as antennae or heating coils, in window glass elements. Additionally, transparent films can be back-injected as an alternative to scratchproof paint coating.



## Overmoulding windows

Overmoulding with thermoplastics or elastomers allows to add a sealing and mounting function to glass panes. The single-step process in injection moulding machines with a horizontal or vertical clamping unit reduces the mounting overhead and avoids costs. ENGEL's complete line of machines offers a customised and yet compact production solution for any size of window glass, any overmoulding material and any process technology requirement. As ENGEL machines can be equipped with plasticising units for both elastomers and thermoplastics, the injection unit can be changed as necessary. The responsive ENGEL mould protection system reduces glass breakage and rejects while improving the availability and productivity of the overmoulding system.

## Reflectors

Reflectors in light units need to have a high surface quality, with properties similar to metallisation. This requires precise moulding using ENGEL's gasmelt gas injection technology to avoid sink marks.

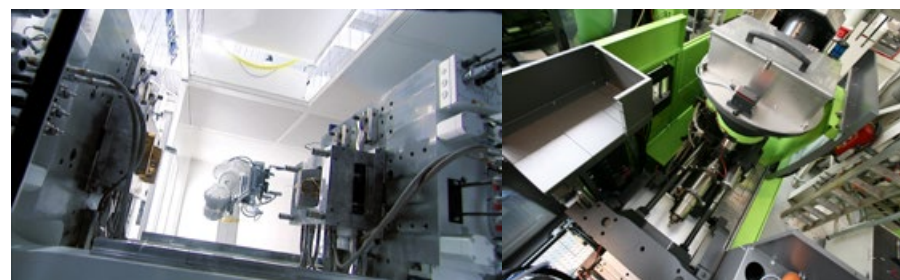
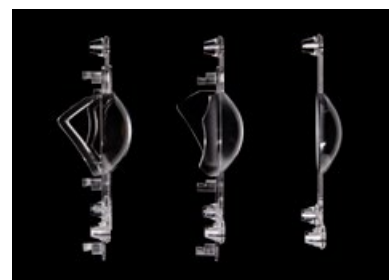
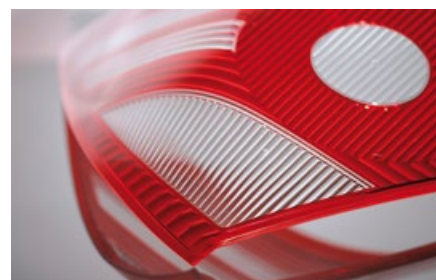
Special screws minimise wear and ensure a long service life when producing reflectors from high-temperature resilient thermoplastics. ENGEL's BMC injection units, designed for processing polyester, allow to injection mould reflectors made of duroplastics.

### Stable processes without interruptions

The rotary feeding units for the ENGEL BMC 50 and HRC 50 roto-feeders ensure maximum process stability when material is fed to the plasticising unit. The material is fed continuously and at a constant pressure. The rotofeeder is also easy to use for the operator.

## Thick-walled look

Multilayer technology and LSR processing support state-of-the-art LED optics.



## Fibre optics and LEDs

Manufacturing light guides and light-emitting diodes with high-quality surface and low internal stress is demanding. High-precision, all-electric injection moulding machines, such as the ENGEL e-motion with its injection-compression function, meet these high demands. In combination with variothermal mould temperature control, even complex geometries and lens effects can be easily implemented in a cost-optimised way.

### Maximum space

The tie-bar-less design of the ENGEL victory allows for easy access to the mould mounting area and a variety of mould dimensions while ensuring maximum stiffness of the clamping unit. Last but not least, the tie-bar-less clamping unit allows to install cleanroom equipment above the mould.

## Diffusing lenses

Diffusing lenses for headlamps pose the strictest requirements in terms of optical quality, non-warpage and surface properties. Due to their size, they are produced using classical injection moulding instead of injection-compression moulding.

### Highest melt quality

Thanks to their special geometries and special non-return valves, ENGEL screws guarantee gentle material preparation also in this application while avoiding the formation of "black spots". After injection moulding the finishers, fasteners are often moulded as a second step using ENGEL combimelt.

## Tail lights

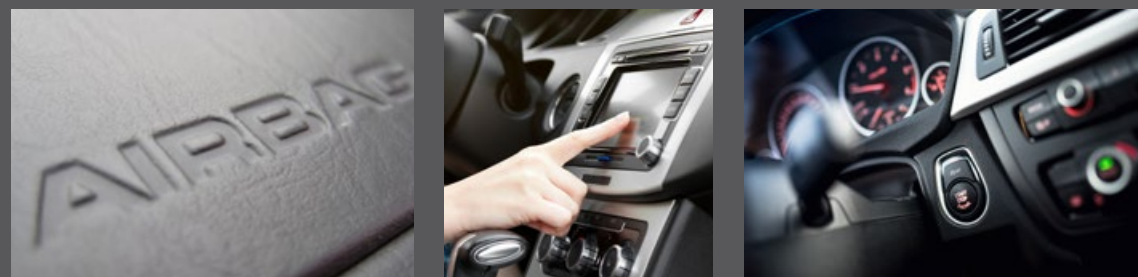
Multicolour automobile tail lights are produced in multi-cavity moulds using the ENGEL combimelt technology and large-scale ENGEL duo machines with integrated rotary tables. Up to four injection units can be placed at different locations on the machine layout as needed, which allows for optimum accommodation to any customer requirement.



## Panels and interior parts

### Premium appeal and functionality

A large variety of plastic components is found in the vehicle interior. Dashboards and consoles hold countless functional elements and have an attractive pleasant look and feel. This also applies to door and pillar trim panels that hold airbag systems for protection against head-on or side impact, and therefore require precisely defined characteristics.



## Visual appeal meets tactile experience

Door trim panels cover mechanical window movement systems, seals, loudspeakers and cables; they are designed to have surfaces that offer a premium visual appeal and tactile experience. Technologies such as ENGEL tecomelt ensure comfort and safety in automobiles.

### High productivity

Whether you need compact injection moulding of trim panels or interior parts, back injection using soft foam films, or the implementation of injection moulded structures on a polyurethane foam moulding system, ENGEL implements all single-stage processes on a multitude of injection moulding machines in cost effective production cells with a high degree of automation.

## Dashboards

Dashboards for vehicles in the lower price segment are usually produced using compact injection moulding. ENGEL offers a wide range of special processes that meet every requirement in terms of soft or decorated surfaces.

### Fit for just-in-sequence

When back injecting soft foam films with the ENGEL foilmelt process, it is possible to change the colour or surface structure from cycle to cycle. ENGEL automation solutions, along with a suitable injection moulding machine, enable efficient and cost-effective production of such parts.





## Dashboard supports

Using an LGF plasticising unit to produce dashboard supports ensures that all requirements in terms of strength, rigidity, and impact resistance are met. A combination of ENGEL foammelt structural foam moulding and the ENGEL coinmelt injection-compression technology allows to optimise the part weight. In addition, we offer automation solutions for inserting airbag nets.

## Pillar trim panels

Back injecting textile structures in an injection mould is how textile-decorated pillar trim panels are produced today – typically on mid-sized injection moulding machines. The tie-bar-less clamping units of the ENGEL victory machine series ensures free access to the mould area, which allows for fully automatic inserting and securing of the cut-to-size fabrics. Robots and grippers can use the entire space and are not obstructed by tie-bars; moulds can be changed quickly and easily. This ensures shorter cycle times while increasing cost effectiveness.

### Use of the entire mould mounting platen

Back injection requires only relatively low pressures, therefore the entire surface of the mould mounting platens can be used for bulky moulds on tie-bar-less machines. In the back injection process, tie-bar-less injection moulding machines fully leverage their greater production efficiency compared to conventional machines with tie-bars.



## Decorative parts

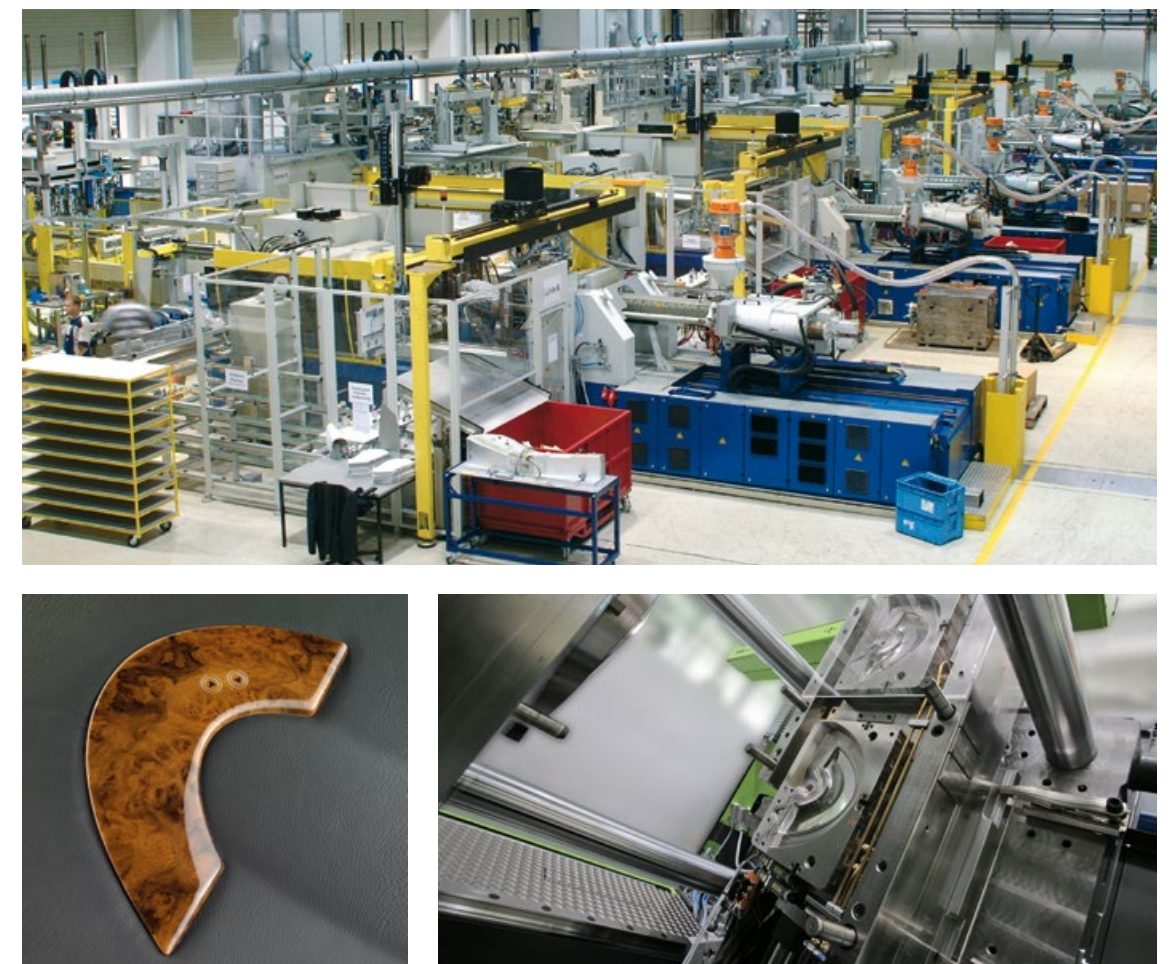
The ENGEL clearmelt technology achieves visually impressive effects on decorative parts with back-injected foil carriers, such as trim panels in vehicle interiors. Using multi-component technology, a thermoplastic carrier is flood-coated with transparent polyurethane which results in scratch-resistant, high-quality surfaces with 3-D effects.

### Time-saving and cost effective production

Compared to standard thermoplastic methods, the required level of scratch resistance and the 3-D effect is achieved with a thin coating using the ENGEL clearmelt method. Conventional coating systems can only achieve a similar quality in time-consuming and expensive multiple coating processes. These processes are prone to very high reject levels due to the multiple stages required.

### A glimpse into the future: capacitive electronics

ENGEL clearmelt also sheds a new light onto the world of switches. This technology also supports flood-coated carriers with integrated circuits which are well-protected by a thin layer of PUR to support easy handling.





## Door trim panels

The ENGEL duo series is used for large door trim panels. The importance of injection-compression technology is increasing as moulded part surfaces become larger and flow paths longer. The ENGEL injection compression programme protects the material during injection, allowing for very low clamping forces. Platen parallelism control ensures uniform distribution of the wall thickness over the entire surface of the moulded part, as well as minimal mould wear. Small batch sizes of very large parts with textile decoration can be produced on injection moulding machines with a vertical clamping unit, using the ENGEL tecomelt process. Using injection units that can be moved in three dimensions, the melt is fed into the open mould and gently pressed onto the textiles with the lowest possible internal pressures. This technology means that significantly simpler and less expensive moulds without hot runner can be used, achieving an economic advantage for small to medium batch sizes.

## Speaker covers

Low-viscosity, easy-flow plastics are typically used to mould grid-shaped loudspeaker covers which have many small surface holes. All-electric machines, such as the ENGEL e-motion, offer sensitive process control: they precisely maintain the tight processing window, provide the best surface finish and prevent overmoulding and burrs. If a moulded part is trapped in the cavity during take-out, the ENGEL machines' reactive mould protection safeguards the mould's numerous sensitive pins to prevent expensive damage.

## Door handles

Thick-walled moulded parts, such as door handles, are often manufactured using ENGEL's gasmelt injection technology. Compared to conventional injection moulding, this technology has a longer holding pressure which results in cleanly-shaped surfaces and moulded parts with low shrinkage and good dimensional stability. This is required for subsequent metallisation or electroplating, which would make surface defects extremely noticeable.



Door trim



Door shoulder

## Support structure for backrests

Support structures, invisibly integrated into the seat, form one of the essential interfaces between the driver and the vehicle – they are manufactured on an ENGEL insert vertical injection moulding machine. The moving structure, made of metal rods overmoulded with plastic, is manufactured in an injection moulding cell. The ENGEL combimelt technology is used to combine the required rigidity with excellent antifriction properties.

## Vent grilles

Air vents have gone down in the history of injection moulding as one of the “classic” moving parts in assembling moulding. They are typically produced in multiple-cavity moulds today. Depending on the moulded part dimensions and the number of cavities, the ENGEL victory or ENGEL e-motion injection moulding machines provide the basis for multi-component injection moulding. Both machine types can produce the air vents in a single operation. Climate control vents for the VW Golf and Audi A3 are produced in a 4+4 cavity mould, combining ENGEL foammelt structural foam moulding with the ENGEL combimelt multi-component technology to form a sealing lip.

## Airbag cover

Airbags covers must have a specific “break-open” property during a crash, but should also be perfectly adapted to the look of the vehicle interior. ENGEL's machine, process and automation technologies insure the process stability to fulfil these requirements.

Safety in production – safety for occupants

Smart products offered in ENGEL inject 4.0 monitor all the relevant process parameters during production.

# Safety, locking and control technology, sensors & connectors Reliability for many miles

Today, it is not only active and passive safety equipment, such as ABS, ESP, seat belts, head restraints, seat belt tensioners and airbags, that mainly consists of injection moulded components. Driver assistance systems, steer-by-wire and brake-by-wire systems also require plastics. Especially for these safety-relevant parts with their sensors, switches and connectors, it is equally important to achieve repeatable product quality as it is to document the production data for the automobile manufacturer.



Mechanical, electrical and mechatronic components for safety equipment are manufactured by overmoulding inserts on ENGEL insert vertical machines.

The self-learning and highly sensitive ENGEL autoprotect mould protection programme ensures the lowest possible mould wear. This reduces maintenance costs to a minimum.

## Seat belts, seat belt buckles, belt tensioners and belt deflectors

Safety elements consisting of overmoulded metal parts are usually produced on small horizontal or vertical injection moulding machines. Modular automation systems for entire families of parts combined with exchangeable mould inserts ensure maximum flexibility, eliminating the need to remove the mould. Aligned machine and automation technology ensures quality testing and preheating of the inserts and keeps placement and take-off times to a minimum.

## Lock housings

Lock housings are complex, highly precise functional parts. A large number of ENGEL technologies are used to produce these: on ENGEL insert vertical machines, metallic inserts are placed in the mould and integrated into the part as functional elements. The required seal is made of thermoplastic or elastomer material in a complete line using the ENGEL combimelt multi-component injection moulding process and an ENGEL elast rubber machine. Furthermore, ENGEL foammelt structural foam moulding enables low-stress, weight-optimised thermoplastic structures.







Efficiency for inserts: the ENGEL e-insert electric vertical machine combined with the powerful ENGEL viper robot.



## Circuits and connectors

Electrical and electronic safety elements consisting of thin, overmoulded metal parts are usually produced on small horizontal or vertical injection moulding machines. As for mechanical safety parts, modular automation systems for a wide variety of parts combined with replaceable mould inserts guarantee maximum flexibility, eliminating the need to remove the mould. Large rotary table diameters permit the use of several workstations that can also be equipped with different moulds.

## Skids and guide rails

ENGEL combimelt combines the optimum slip properties of polyoxymethylene (POM) with the high strength of polyamide (PA), resulting in a part with defined frictionless properties for maximum operating comfort. In the case of window guides, the TPE component offers optimum dampening performance between the window and the POM guide element.

## Switches and buttons

Switches and buttons with a function and a label or pictogram are manufactured using ENGEL's combimelt multi-component technology. For example, a 130-ton ENGEL victory machine with an ENGEL take-off robot can produce switches made of polyamide and two POM types in a 4+4+4 cavity mould. Assembling moulding is a cost-optimised method to produce functionalised moving plastic parts.

## Airbag igniters

Today, injection moulding is also used to manufacture ignition components for occupant and pedestrian safety bags. To do so, the pyrotechnic material is overmoulded directly on an all-electric, tie-bar-less ENGEL e-motion injection moulding machine. The machine offers the optimum conditions for automation while reducing the cycle time and increasing production. Due to maximum precision during injection and the required mould protection, it is the perfect solution for working with highly explosive material.

## Parking brake levers

ENGEL combimelt combines appealing haptic and visual features with best-in-class mechanical properties. Large moulds with low clamping force requirements – the tie-bar-less ENGEL victory machine is the ideal solution for injection tasks of this nature.

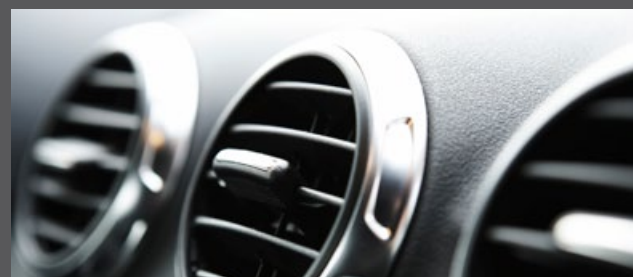
## Switchless control panels & HMI sensor system (centre console)

Film technologies such as insert moulding and in-mould decoration enable state-of-the-art control panels manufactured using the injection moulding process. The switching functions are already integrated in the part as foils.



## Ventilation and air-conditioning technology Perfect quality for more comfort

A pleasant climate control of the vehicle interior makes car occupants feel comfortable. Operation and control, compressors and heat-exchangers, along with air ducts, air vent actuators and vents rely on a large number of plastic parts that all need to be as lightweight and compact as possible. This explains why many components are weight-optimised and foamed using ENGEL's foammelt technology.



## Electric motor mount

Drivetrain components are not allowed to generate noise or transfer oscillations or vibrations to other structures. For this reason, they are acoustically insulated and mechanically separated. In a fan motor bracket, the mount – overmoulded with TPE using ENGEL com-bimelt – dampens vibrations and also noise emissions.

## Housing parts, air vent and fan blades

As the market leader for the MuCell® physical foaming process, ENGEL has successfully created machines that can produce a wide range of products. ENGEL's foammelt structural foam moulding process allows to improve the quality of housing parts for the rear climate control system in the Mercedes-Benz S-Class, developed and produced by Behr, while reducing the cycle time.



The fully automatic ENGEL famox (fast mould exchange) mould setup system ensures optimised setup times for medium batch sizes.



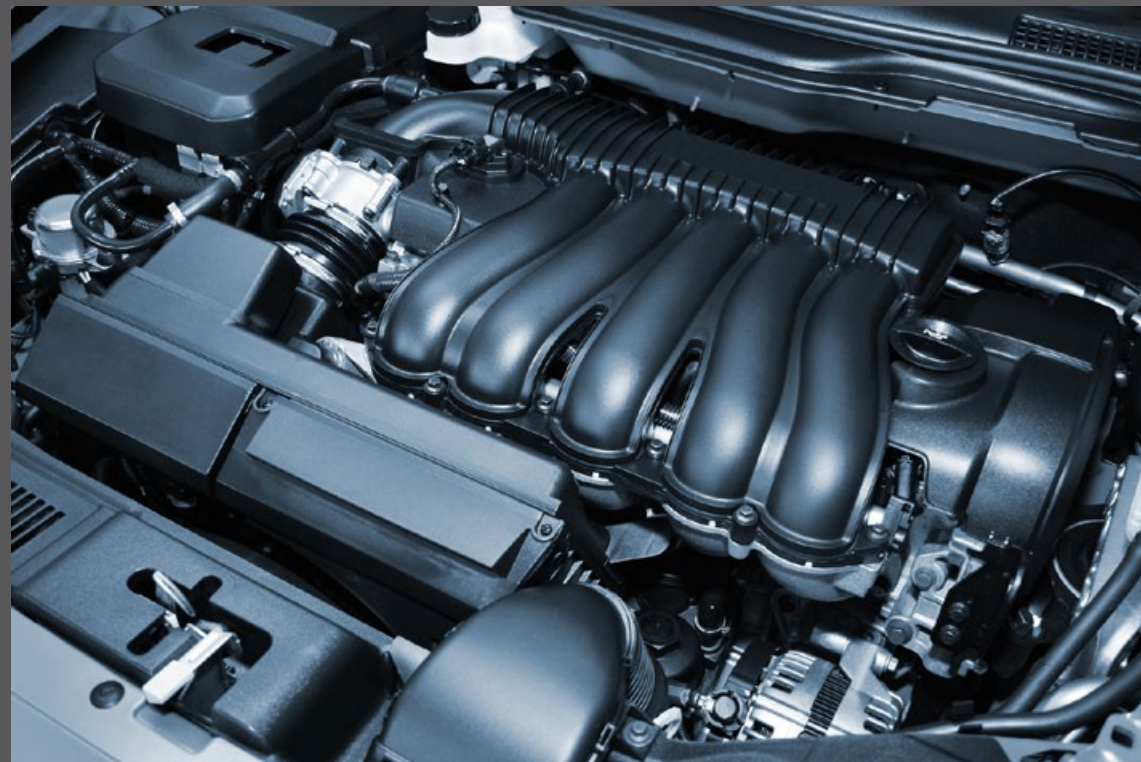
Source: Behr



# Engine compartment

## Robust, lightweight and temperature-resistant components

There is an increasing trend towards manufacturing engine components and engine-related subassemblies from plastics. Today, custom-built, injection mouldable plastics are perfectly suited for high operating temperatures and contact with fuel, oil, coolant and brake fluid. As a result, new high-performance parts with minimum weight are continuously being developed for the very tight package space in the engine compartment. The range of applications extends from decorative cylinder head covers through intake manifolds and intake modules, connectors for the electrical system and parts of the fuel system to flaps and valves for heat management and climate control. ENGEL's innovative production solutions for injection moulded plastic parts make it possible to replace metal with plastic in the engine compartment.



## Engine covers

Although pure design parts, engine covers are subject to higher temperatures. This explains why they are injection moulded from glass fibre-reinforced plastics. Design or sealing elements often require the use of the ENGEL combimelt multi-component technology. The high process capability of injection moulding machines by ENGEL means that high-quality surfaces can be produced for electroplate finishing, rather than just hot embossing or painting.

## Valve covers

For example, ENGEL machines are used to manufacture valve covers from glass-fibre reinforced polyamide.

## Air intake manifolds

On a 1500-ton ENGEL duo large-scale machine, air intake manifold parts are made of PA66-GF using compact injection mould; these parts are then welded together. Variable mould temperature control achieves an optimum mould wall temperature, which ensures the tight tolerance range for the component geometry, as needed to weld half-shells. The use of group moulds ensures uniform manufacturing conditions for the two individual parts that are to be welded together subsequently.

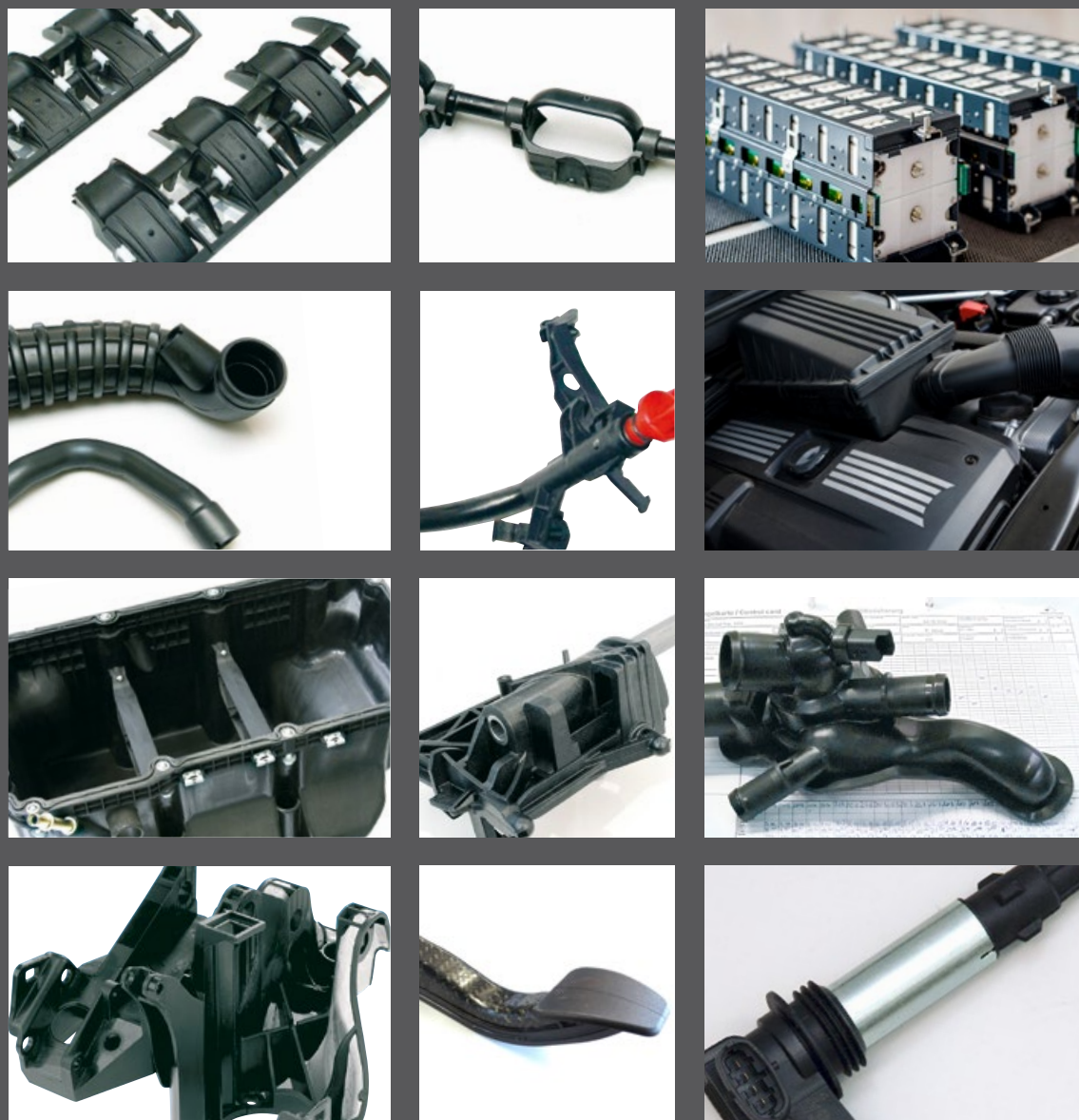
## AdBlue® tanks

SCR catalytic converters use AdBlue® to reduce the nitrogen oxide (NOX) emissions in the exhaust gas. Our injection moulding solutions ensure reliable processes to guarantee the flawless production of these media components.



AdBlue® is a registered trademark of VDA.





At SchneeGans, two coupled injection moulding machines rely on two-component technology to produce turn.

## Air intake flap

In the production of air intake flaps, ENGEL demonstrates the combination of two-component technology and assembling moulding at the highest technical level: two interlinked injection moulding machines produce a set of air intake flaps with ready-to-fit flap systems for V6 and V8 engines, including assembling moulding, final assembly and 100 percent inspection.

### Pick & Place and overmoulding

In the first 300-ton ENGEL victory combi injection moulding machine, the body is first made of PA46-GF15 in a 2+2 cavity mould; after the part is moved using a linear Pick & Place robot, it is overmoulded with PPS in the second mould position. The robot on the second ENGEL victory 130 combi injection moulding machine picks up these sets of two and positions them in the first injection station of the mould, where a lever of the same PA is moulded on. After transferring, rubber seals are vulcanised onto the flaps.

### Easy access to the mould area

Benefits with the ENGEL victory: the tie-bar-less clamping unit provides enough room in the mould mounting area for complex two-component injection moulds and end of arm tooling on the robot.

## Bracket for a turbocharger air volume control

Exposure to high temperatures and the elements, and its low tendency to creep, require the use of vulcanising rubber as a sealing element. To manufacture this bracket, ENGEL combines processing of two components, rubber and thermoplastics, in a single mould, which is thermally isolated to provide for a hot and a cold area. The two components are joined without using a bonding agent.

## Intake manifolds made of NBR/HNBR

Combining an ENGEL elast rubber injection moulding machine with state-of-the-art robot technology resulted in a globally unique intake manifold production cell for the automobile industry at AR-TEX Spa in Italy. The two machines can be linked or used for fully-automatic stand-alone production. The key to this system is sophisticated part removal. Perfect interaction of the gripping function, a sufficient volume of compressed air and the demoulding system, which emulates the motion of a human hand, are the essential elements that allow moulded parts to be pulled off the core without damage.

## High-voltage battery systems

Thanks to precision moulding of technical thermoplastics and high machine availability, solutions from ENGEL meet the diverse requirements in the manufacture of components for electric mobility.



## Manifold units

Highly complex functional parts for the engine compartment usually require injection moulds that are equally complex. A large number of sliders and media connections increase the space requirements in the injection moulding machine, despite the fact that the required clamping force is usually low. Machines with tie-bar-less clamping units offer the benefit of a freely accessible mounting plate. This is useful both in terms of downsizing the machine, and at mould set-up time.

## Gearshift and selector levers

In order for the operating forces and the operating feel to be the same for all transmissions in a vehicle series, gearshift levers must have a particularly consistent, uniform quality. Overmoulding two metal parts with glass fibre-reinforced plastic helps to integrate an opening for a cable linkage (among other things) in metal tubes. ENGEL supplies a complete solution including a vertical machine and robot for this: the tubes and the cable linkage are inserted by the robot, while the finished parts are removed automatically.

## Oil dipstick, media pipe

Oil dipstick guide tubes with a curvature, made of PA66-GF, are manufactured using ENGEL's watermelt water injection technology. Even media lines with branches and a multi-layer structure can be produced cost effectively, fully automatically and quickly in a single operation with a combination of ENGEL combimelt and ENGEL watermelt. Although the pipes are made of glass fibre-reinforced plastics, their interior surface is smooth. Pipes for coolants also have a media-resistant inner layer.

### Greater precision

ENGEL is the first provider to save space by integrating a water injection unit with piston injection below the clamping unit directly in the injection moulding machine's frame. This mechanical and control system integration reduces pressure loss, allowing for more precise control and better repeatability compared with conventional systems.

## Oil pans

The first commercial vehicle oil pan made of plastic, for the V6-engined Daimler Actros truck, was manufactured on an ENGEL insert vertical machine using fibre-reinforced polyamide PA66-GF35. The inserted and overmoulded metal bushings are used for fastening on the engine block. Compared with the classic sheet-metal variant, the plastic oil pan offers significant weight savings.

## Clutch pedal

The pedal itself consists of PA66-GF30 and is manufactured using ENGEL's watermelt technology. The bearing block is produced on an ENGEL insert vertical machine by overmoulding the metal bearing. The pedal cover is injection moulded in natural rubber on an ENGEL elast vertical machine.

## Pedal bearing blocks

Pedal bearing blocks support the brake and clutch pedals in passenger vehicles and commercial vehicles. They are currently manufactured from plastic and galvanised sheet metal using a hybrid method. In fully-automated manufacturing cells surrounding an ENGEL injection moulding machine, the three-dimensional blank is inserted into the injection mould and overmoulded with plastic.

### Hybrid technology integrates fasteners

The attached plastic ribs stiffen the design and prevent the galvanised sheet from collapsing if overloaded. The metal's high modulus of elasticity permits a filigree overall design, while the ductile behaviour of the sheet metal prevents the component from breaking or falling apart in case of a crash. Overmoulding with plastic also means that fasteners for add-on parts such as switches and sensors can be integrated.

## Dampening elements and spark plug connectors

Dampening bushes for a passenger vehicle axle can be manufactured by combining the ENGEL elast and ENGEL insert machines. Modified PPE-GF20 replaces the metal formerly used. It is overmoulded with an elastomer and fulfils the same functions as a heavy moulded part of metal and rubber.

### Cost effective mass production

Air hoses, spark plug connectors and sealing elements such as O-rings on moving parts and single-wire seals in automobile electrical systems are also produced from conventional, curing elastomers, or made of curing liquid silicone rubber (LSR) using the ENGEL elast and LIM solutions.



## ENGEL services

### Superb individual support

- **OEM parts**  
A perfect fit, reliable, durable
- **ENGEL formula 24**  
Our formula for success and enhanced safety
- **Plasticising units**  
For improved cost effectiveness, performance and service life of injection moulding machines
- **Retrofit**  
Continuous high quality output and availability
- **ENGEL care**  
Our maintenance packages for continuous high results and optimal quality output
- **ENGEL Protect**  
Intelligent system protection by ENGEL
- **Oil maintenance unit**  
Reduced maintenance costs and less unplanned machine downtime
- **Hose service**  
Improved safety by regular replacement of hoses
- **ENGEL everQ**  
Verified process reliability of production-relevant sensor data with test certificate
- **ENGEL relocation service**  
The optimal solution for machine re-locations – whether within the company, within a country or across borders
- **ENGEL training**  
Be ready for your production requirements
- **Consulting & Coaching**  
Find and leverage hidden potentials
- **e-connect**  
Your complimentary portal for ENGEL services
- **e-connect.monitor**  
Monitoring of process-critical components during operations for predictive maintenance
- **e-connect.24**  
The 24/7 remote maintenance package

## A broad machine portfolio – a comprehensive service portfolio

At ENGEL, we not only offer the latest technologies and state-of-the-art production systems, but also a broad range of services to ensure your long-term success. A versatile team of experts provides service and on-site support, quickly available, high-quality retrofitting and optimisation tools, as well as professional consulting and training. With our support you get the best out of your production cells.

### Support – we assist you on-site!

- save on downtime costs
- immediate worldwide 24/7 support
- expert support from the ENGEL service team
- for any ENGEL injection moulding machines no matter the generation
- for all ENGEL technologies and any control unit version

### Upgrade – install reliable added value!

- for all ENGEL injection moulding machines
- individual upgrading of your machine in OEM quality
- to add and optimise functionality
- equip machines for use with new applications and technologies
- utilise machines with even greater cost effectiveness

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- comprehensive training with a focus on knowledge transfer
- make the most of your machine's potential
- individual seminars and training programs for you and your employees
- informative events on industry-specific topics
- take advantage of efficient, targeted and practical information, instruction and training
- either at your own facility or at one of the worldwide ENGEL training centres





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