

Global ENGEL DUO production network

Yet another milestone

>> Towards the end of last year, Engel reached yet another milestone in its corporate history with the further expansion of its worldwide local presence as a globally leading manufacturer of injection moulding machines: Engel's new large-capacity machine factory in China – Engel Machinery Shanghai – was completed last year according to schedule and the first ENGEL DUO "made by Engel Shanghai" for the Asian market was already assembled and despatched before the end of December 2006. Engel can now fully implement its strategy of operating local production facilities both for small and for large-capacity machines in the three large economic regions of the world, namely Europe, America and Asia. The Shanghai factory is now the third production facility geared for the manufacture of ENGEL DUO large-capacity two-platen machines; small and medium-sized machines of the tiebarless ENGEL VICTORY series with clamping forces ranging from 200 to 4,000 kN have been produced by Engel's facility in South Korea for the Asian market since 2001.

Through its new Chinese production facility, Engel can now offer customers in the Asian market for DUO machines (6,500 to 15,000 kN clamping force) a "productivity advantage" of around six weeks, this being the time previously required for shipping such a large machine from Engel's factory at St. Valentin in



Austria: DUO assembly at Engel Austria, St. Valentin.

– such as machine control systems and injection units – from its central technology centres in Austria. As in Engel's American facility in York, the clamping units are manufactured by the Shanghai facility itself, for experience has shown that these units mostly necessitate a high degree of adaptation to specific applications. Here, too, Engel has ensured its high standard of quality by equipping



China: The employees of Engel Machinery Shanghai with their first locally assembled DUO.

Austria to a destination in Asia. Moreover, the proximity of the Shanghai factory also makes for shorter reaction times all told – in cases, for example, where the customer still requires modifications as late in the day as the acceptance test and/or would like to have additional equipment fitted.

Uncompromisingly high Engel quality

As with the three small-capacity machine factories in Schwertberg/Austria, Guelph/Canada and Pyoungtaek/Korea (cf. "injection 11", June 2005), the new Chinese factory is based on essentially the same concept as the two other large-capacity machine factories in Austria and the USA. In order to safeguard its technological identity, Engel supplies key compo-



USA: DUO assembly at Engel Machinery Inc., York.

Engel Shanghai with the same machining centres as used at St. Valentin in Austria. Engel's global Intranet system permits the joint utilization of machining programmes, thus guaranteeing a uniformly high level of processing reliability while preserving the high degree of vertical integration in each individual facility. As in the USA, the Shanghai facility uses the local market for outsourced parts, especially cast iron and steel products.

>> Thus an ENGEL DUO "made by Engel Shanghai" features exactly the same standard of technology and quality as a DUO "made by Engel Austria" or a DUO "made by Engel North America". The advantages of local production in Asia consist primarily in faster deliveries through shorter transport distances and in greater competitiveness through the saving in transport and material costs that Engel passes on to its customers. <<

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>> **Page 9:** BASIC – PROFI – EXPERT – TECOMELT – these are Engel's four modules tailored to the practical requirements of injection-compression moulding.



>> **Page 10:** Which type of robot does one choose for the fully automated injection moulding machine: a linear robot or an industrial robot? A comparison of performance features provides the answers.

Supplements

>> **injection Asia**
>> **injection North America**

Dear Customers,

The plastics industry in Europe is "back on the road to recovery". The yardsticks of this welcome development are the increases in sales together achieved in the last business year by plastics processors, raw material producers and plastics machinery manufacturers. And the positive expectations of our industry for "K year" 2007 certainly outweigh the negative ones. But whilst it can be said that the economic trend is upward, we do not yet know for sure whether it will gather any sustainable momentum.

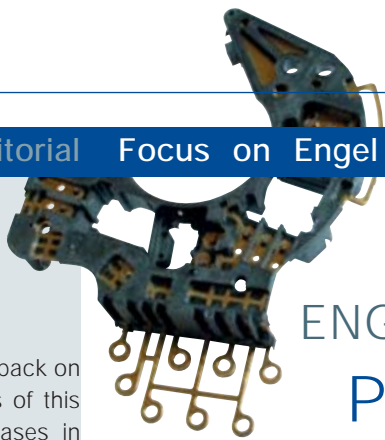
It is not least in such times as these that the processor must be able to place his trust entirely in the supplier of his machines – and for the long term, too. Takeovers of companies – or even only parts thereof – of the kind we have recently been witnessing in the plastics machinery industry, and which will certainly be just as much in evidence in the future, are in this regard an additional insecurity factor. A change of ownership not infrequently leads to a lasting deficit in overall performance.

For us at Engel, reliability and predictability are vital for a customer's long-term planning and therefore rank high in our corporate philosophy. As a long-established, family-owned company, we operate on a sound, time-tested basis that ensures absolute continuity in our dealings with our customers. Like many of our customers, we, too, are globally oriented. We have developed all the necessary local infrastructures steadily and continuously through our own financial resources. A particularly apt example of our commitment to this policy of global orientation is our newly built large-capacity machine factory in Shanghai. Even in Europe, we have been able to extend and further consolidate our already broad network of branches and subsidiaries through the addition of Engel Russia, Engel Ukraine and Engel Romania.

In 2007, we shall be tailoring our sales organization even more specifically to the needs of our customers – through five Business Units for the five branches of industry in which our customers mainly operate: Automotive, Technical Moulding, Packaging, Medical and Teletronics. These Business Units will concentrate their expertise on the requirements of their respective branches of industry, thus being better able to translate customer's needs and problems into optimum solutions. Moreover, each Business Unit will be globally oriented and hence readily able to provide customers anywhere in the world with the same information and within a coordinated structure.

Whilst success is based on continuity, it must always be accompanied by constant innovation. Continuous developments and further developments in machine and processing technology are likewise a tradition at Engel. We are committed to constantly redefining the limits of injection moulding. Examples of new developments will again be the focal point of our presence at this year's "K" in Düsseldorf from 24th to 31st October: innovative products manufactured intelligently and economically with Engel technology – and with Engel as a partner offering absolute reliability in the extremely long term.

Yours sincerely,
Peter Neumann
CEO Engel Holding

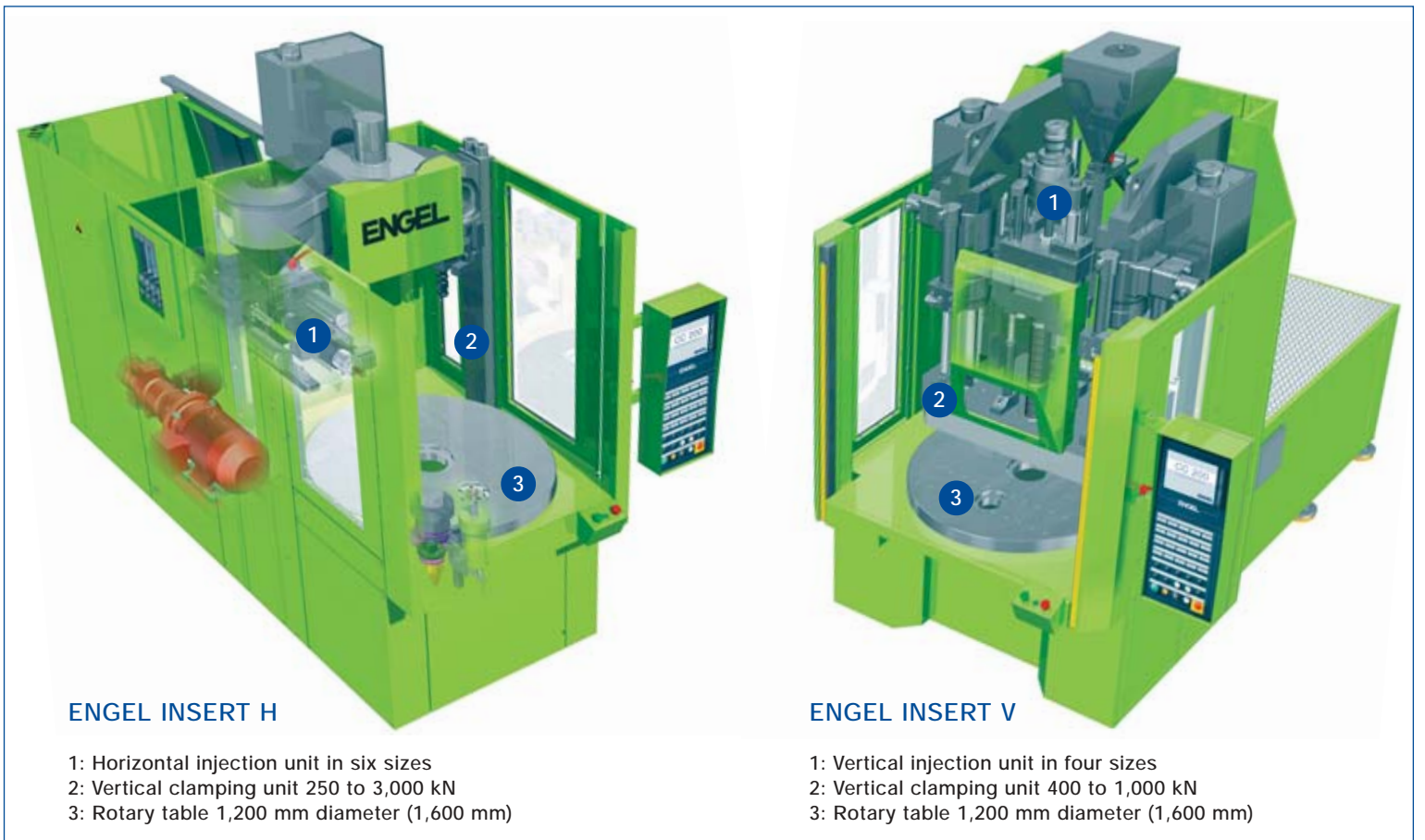


ENGEL INSERT Plenty of potential for in-mould assembly



Machines with vertical clamping units are the "hidden champions" in Engel's portfolio: they have been giving service for the past 30 years and already featured a tiebarless clamping unit and modular design several years ahead of the standard "Victory" machines. Despite these qualities, the vertical machines of the ENGEL INSERT series – and also their potential for the rational production of complex composite parts – are often known only to insiders.

removal of the moulded composite part are time-consuming operations and hence necessitate a longer production cycle. The use of a rotary table with two or more stations in addition to the injection station represents the most economically efficient solution, as it permits simultaneous parts handling – either manual or automated – and injection moulding. Such "insert machines" are – as their name implies – specially designed for applications involving the placement of inserts into the mould cavity.



ENGEL INSERT H

- 1: Horizontal injection unit in six sizes
- 2: Vertical clamping unit 250 to 3,000 kN
- 3: Rotary table 1,200 mm diameter (1,600 mm)

ENGEL INSERT V

- 1: Vertical injection unit in four sizes
- 2: Vertical clamping unit 400 to 1,000 kN
- 3: Rotary table 1,200 mm diameter (1,600 mm)

>> Composite parts are no longer destined for a niche market – they count among the most important rationalizing aspects of our time. When it comes to combining plastics featuring different properties or colours in one multicomponent part, Engel's "Combimelt" process is the one to use. It has become a standard process in all its many variants and a wide range of multicomponent machines is available for use with it.

But if the composite part is not completely plastic but has a component made of some other material, e.g. metal, the injection moulding machine must also accommodate insert-placing systems. Typical examples are knives or screwdrivers with plastic (often multicomponent) handles, cables with integrally moulded plugs and sockets, integrated metal circuits embedded in plastic. Often difficult to handle, the metal parts have to be separated, inserted into the mould cavity and then held exactly in position – no mean task when it comes to the handling of such parts as cables or tubes, stamped metal circuits, sensors or solenoid valves, or special plastic components that have

to be embedded in another plastic or combined with other functional plastic components. A horizontal mould cavity best meets the prerequisites for the placing of the insert and its subsequent transfer to the injection station. Both the placing of the insert and the



ENGEL INSERT machines are also available as specials with sliding tables as an alternative to the standard versions with rotary tables.

ENGEL INSERT: tiebarless clamping units throughout

All the machines of the ENGEL INSERT series are equipped with a tiebarless clamping system, the design principles of which are in many respects similar to those of the standard tiebarless Victory machines. The resultant advantages are identical:

>> Unrestricted access to the clamping unit – ready combinability with rotary or sliding tables – compact overall dimensions in spite of rotary table facility.

Two versions: INSERT H and INSERT V

The machines of the ENGEL INSERT series are available in two basically different versions. While both versions are equipped with tiebarless, vertical clamping units, they have differently positioned injection units.

INSERT H: The basic and most used version is the INSERT H, which is a combination of a vertical clamping unit with a horizontal injection unit. Four sizes of machine in the clamping force categories 250-900 kN, 1,000-1,250 kN, 1,500-2,400 kN and 3,000 kN – in conjunction with rotary tables of 1,200 mm diameter (1,600 mm for inserts measuring 150 mm and over) – are available as standard.

INSERT V: The alternative version is the INSERT V, which is a combination of a vertical, rotary table-equipped clamping unit with a vertical injection unit. The injection unit is mounted on the upper (moving) platen and moves with the latter when the clamping unit opens and closes. The additional weight of the injection unit on the moving platen naturally limits the range of available combinations. Consequently, only two sizes of machine are offered in the clamping force range from 400 to 1,000 kN, with four sizes of injection unit from ES 80 to ES 500. A rotary table of 1,200 mm diameter is standard; 1,600 mm diameter is an option.

The advantage of the INSERT V machines lies in their ability to accommodate “standard” moulds with central gating. This is a definite quality advantage when using multicavity moulds, as symmetrical, well balanced hot runner systems can be used. This also has a positive effect on overall precision.

Program tailored to user requirements

Like all other Engel injection moulding machines, the vertical machines of the ENGEL INSERT series are equipped with the modern EC/CC 200 machine control system. The sequence program is optimally adaptive for parts handling. The production cycle – even complex sequences – can be configured with either defined or programmable modules.

Where machines are equipped with rotary tables, such operating elements as air valves, core pullers and other controllable mould components can be differently programmed, depending, for example, on what tasks are to be performed in the injection or parts-removal station.

What is **new** is the machine's ability to program its functions independently of the parts-removal and insert-placing sequences and movements, which means that the latter can now be optimized in parallel with the injection moulding process without any functional limitations. This in turn means a saving in cycle time. Actuation of the rotary table via a proportional valve with electronic angular measurement gives an analogous advantage: the fastest possible rotational speed.

Rotary tables are offered as standard with either three or four stations. Special versions are also available.

All told, the economically efficient machines of the ENGEL INSERT series offer enormous value creating potential for the production of innovative composite parts – the only limits are those of the imagination! <<



Free access to the rotary table-equipped clamping unit creates the prerequisites for the installation of handling devices and robots.



Three-component switch Completely assembled in the mould

>> The three-component switch is produced in three stages. Arranged one above the other in the mould are three stations each comprising four mould cavities. Production begins in the bottom station with the moulding of the switch housing (PA 66 with 40 % glass fibre content), which is then transferred to the middle station for the in-mould “fitment” of the moving switch lever in the second material (POM with 30% glass fibre content). The two articulated levers (POM) are then added in the third injection cycle in the top station.

The moulded parts are transferred from one station to the next by an ENGEL ERC linear robot. In each cycle, the complex gripper unit handles twelve moulded parts and 14 sprues and runners simultaneously. The eight moulded parts from the bottom and middle stations are positioned in the next higher stations with an accuracy of within 0.01 mm. When removing the four finished parts from the top station, the gripper unit separates the eight sprues and runners and places the finished parts – sorted according to cavity – and the sprues and runners separately on a conveyor belt. The cycle time is just under 30 s.

Gauge-like precision

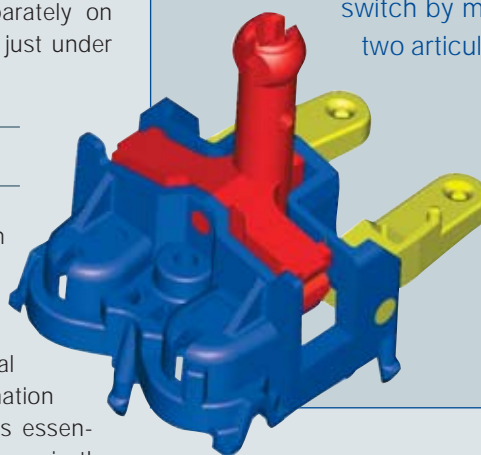
The transfer of the parts from one station to the next makes the highest demands on mould precision. This applies not only to the mould inserts with the individual cavities but also to the coordination between the three stations, as it is essential, for example, to prevent overspray in the second and third stations. All cavities compensate the shrinkage of the moulded parts from the previous station. To ensure uniform shrinkage of all four moulded parts, the runner system has been rheologically optimized (all three materials are fed to the cavities via three partial hot runners, i.e. the sub-runners for each pair of cavities in each station take the form of cold runners).

This extremely high precision was designed into the mould from the very beginning. All mould inserts and cavities, for example, feature gauge-like quality and accuracy. Theoretically, a part moulded in the first station could be placed in any one of the four cavities of the middle station – and the same goes for the transfer of the part to the top station). This 100% dimensional uniformity permits full interchangeability of the four inserts in each station, a feature that considerably facilitates

maintenance: if a mould insert has to be replaced, the new insert will be an absolutely exact fit irrespective of its position in the station. Indeed, ease of maintenance was one of the mould designers' priorities from the very outset: all inserts can be readily replaced from the front without any need to remove the mould halves from their platens.

The switch from Kostal ...

... serves as a sub-assembly for the electrical seat and mirror adjusting system of a passenger car. The starting point of this development was the customer's wish for a noiseless switch with a “soft yet definite switching action”. The new injection moulded three-component switch assembly is subsequently fitted with an LSR contact mat which is retained in the switch by means of the two articulated levers.



The complexity and precision of the mould are also reflected in the gripper unit of the robot, which is just as important as the mould itself for the overall result. For the precision operations of removing the parts from the cavities and transferring them to the cavities in the next station, the gripper unit aligns itself by means of the centring holes of the mould. Mould safety is ensured by every possible means, including optical sensors in the grippers that automatically monitor the removal of the parts from all cavities.



Four switches each with four interconnected moving parts in three different materials – completely assembled in the injection mould. The 4+4+8-cavity mould used for this application is the nucleus of the fully automatic multicomponent injection moulding machine built by Engel – as a complete supplier – for Leopold Kostal GmbH & Co. KG, Lüdenscheid/Germany.

Cooperation from the very outset

The rapid and successful realization of this complex project was ascribable not least to the close cooperation between Kostal and Engel. Engel's mould designing experts, for example, were already “on board” when the switch was still on the drawing board, while Engel's application and automation engineers likewise teamed up with Kostal's plastics processing experts. Thus it was possible to ensure a well thought-through and absolutely suitable part design from the very outset.

Kostal deliberately placed this project in the hands of just one manufacturer who could supply a complete system, for such applications necessitate optimum interaction between the injection moulding machine, the mould and the automation equipment. Kostal is highly satisfied with the system solution supplied by Engel. Although both the injection mould and the gripper unit of the linear robot are extremely complex, the system works absolutely reliably:

>> A three-component switch, in-mould assembled fully automatically in one injection moulding machine without any further downstream finishing.

The machine is a tiebarless ENGEL VICTORY 200H/80W/80v/110-3F (with three injection units in standard, piggyback and vertical arrangement).

>> Engel's mould designing experts certainly are the people to talk to when it comes to incorporating assembly operations directly into the mould – with Combimelt technology from Engel. <<



With an area of only 49,034 km² and a population of around 5.5 million, Slovakia is one of the smallest countries of the European Union. And yet, despite its surveyable size and its still short history of independence since 1.1.1993 – Slovakia is one of Europe's most dynamic regions. One reason might be that the Slovaks – only seldom having been masters in their own house, although they have populated this region since the 7th century – know how to make full use of their newly won independence. And the results are more than impressive. Slovakia's success is ascribable both to its endeavours to revitalize the state-run, meanwhile privatized enterprises of the former centralized economy and

Mobis – Operational since 2006, the production facility of the largest Korean automotive supplier is geared for the just-in-time supply of front and rear bumper and cockpit modules for KIA cars. The main components are injection moulded on large-capacity ENGEL DUO machines.

1

Mobis Slovakia/Zilina Teamwork is the key to success

>> With a population of around 85,000, Zilina is Slovakia's fifth largest city and is situated about 200 km north-east of Bratislava. Today it is one of this country's three centres of the automotive industry, the other two being Bratislava (Volkswagen) and Trnava (Peugeot).

Hyundai/KIA in Zilina has been producing the KIA cee'd, a mid-range car model similar in size and type to the VW Golf, since the beginning of 2007. In addition, Hyundai is in the process of building a second production facility in the North Moravian town of Nosovice in the Czech Republic (production is scheduled to commence in October 2008). But it is not just the car manufacturers that are investing in this region. The same suppliers and development partners who already serve the car manufacturers in their home markets are there as well, for it is only logical that these business relationships continue when such investments are made abroad. And since deliveries are usually effected today on a "just-in-time" basis, these suppliers have set up their production facilities in the immediate vicinity of the car assembly plants. In Hyundai/KIA's case, such large-scale investments have already been made by its most important Korean suppliers, such as PLAKOR (manufacturers of large injection moulds and plastic components) in Mosov near Nosovice/CZ, Sung-Woo HiTech (manufacturers of pressed metal parts) with one factory in Ostrava-Hrabová/CZ and one in Zilina/SK, and Hyundai-Mobis, likewise in Zilina. The Hyundai factory presently being built in Nosovice will also be supplying gearboxes to the KIA factory in Zilina.

Mobis Slovakia s.r.o. (www.mobis.co.kr), whose branch factory in Zilina was one of the

stops on our journey through Slovakia, has its origins in Hyundai Precision Industry (HPI for short), which was established in 1977 as a direct subsidiary of the Hyundai Group. This company was set up specifically for the large-scale manufacture of cargo containers and within only three years it had taken over the market leadership from the Japanese. Business activities were further expanded in the 1990s, when HPI became a contract vehicle manufacturer. It was during this period that the car models Hyundai Santamo and Hyundai Galloper (a Mitsubishi Pajero built under licence) were produced.

The company's activities at this time also included a large-scale contract for the assembling of coaches for the Seoul-Busan high-speed train. The restructuring of the Korean economy in the late 1990s, initiated by the International Monetary Fund (IMF), also led to a restructuring of Hyundai Precision Industry. It was decided to sell off the heavy-industry factories in order to concentrate on the manufacture of automotive components higher up in the integration chain. In 2000, HPI sold its container production abroad and took over the car components business of Hyundai Motor and KIA Motor.

Renaming the company "Hyundai Mobis" in November of the same year was an outward sign of this new beginning. The sale of its large-parts production facility to the Korean rail vehicle manufacturer Rotem marked the final stage of its restructuring programme. Hyundai Mobis is currently the largest Korean manufacturer of automotive components. Its specialities are the vehicle modules "Chassis", "Cockpit" and "Frontend", including their JIS (just-in-sequence) delivery to the assembly line. This explains the investment concept behind Mobis Slovakia: the factory in Zilina is located in the same industrial park as the KIA

factory and in the immediate vicinity of the latter's production lines.

When it came to installing the necessary injection moulding machines, Mobis decided in favour of Engel technology. The initial contact between Hyundai Mobis and Engel was established via Engel Korea. After the signing of the purchase contract, Engel Austria handled the manufacture and installation of the machines and the training of the machine operators. One of the decisive factors in favour of Engel, besides the advanced technology offered, was Engel's close geographical proximity and hence the assurance of receiving prompt after-sales service.

Mobis invested in a total of eight large-capacity injection moulding machines – types ENGEL DUO 16050/2300, 23050/2700 and 23050/3000 – equipped with demoulding robots. It is interesting to note that three of the production cells are equipped with so-called bent-arm robots, while the remaining five are equipped with ENGEL ERC linear robots.

The reason for this varied choice of robot lies in the downstream processing sequences. The machines equipped with bent-arm robots produce front and rear bumpers that first have to be degated and then flame-treated locally on the inside to condition them for downstream assembly. This sequence of operations can be more easily handled by bent-arm robots than by linear robots. For their part, the large-capacity ERC linear robots are used in the production of, among other things, so-called hybrid parts comprising complex metal frames that are inserted into the injection moulds and then encapsulated. A double portal arrangement permits simultaneous insert placing and part removal.

Besides bumpers, the production range of Mobis Slovakia comprises dashboards and frontend modules of hybrid metal and plastic construction.

Before the end of this year, Mobis Slovakia will switch from trial to mass production, the daily target then being 1,000 cars. And for that, perfect teamwork will be the order of each and every day. <<



Keun Young Lee, Vice President Mobis Slovakia: "The tight schedule was a challenge for everyone involved in the project. Engel kept to the set deadlines."

Slovakia Tiny country,



3

Fremach/Trnava Specializing for success

>> Fremach Trnava s.r.o., which began life as Punch Products Trnava s.r.o. in 1993, the year the new Slovakian Republic was founded, can already look back on an eventful past.

Going by its new name since 1st January 2007 (www.fremach.com), this Slovakian company in Trnava – about 50 km north-east of Bratislava – was originally part of the Contract Manufacturing Division of the Belgian conglomerate Punch International N.V. Its main business was the contract assembly of electronic componentry for television sets and other consumer electronic products or electronic car components. Its first customer was Grundig/Vienna, later to be followed by Xerox, Philips, Sony and General Motors.

In 1998, Punch began to transfer several of its injection moulding machines from Belgium to Trnava with the aim of extending the Slovakian company's manufacturing scope to include the production and assembly of injection moulded parts. By 2002, the company was employing around 700 to 800 people during its peak production periods.

The decision to concentrate primarily on the production of parts led to the gradual transfer of assembly work to a factory in Nameštovo in northern Slovakia. From 2002, considerable investments were made in large-capacity injection moulding machines (ENGEL DUO 1000, 1300 and 1500). Today the company has 38 machines in service, a good 90 percent of which are from Engel. 16 machines have a clamping force of over 3,500 kN (up to 24,000 kN).



Mobis – In the production facility, different robot systems are used according to their respective "talents": linear robots for long traversing distances and simultaneous insert placing and part removal (left) – industrial robots for complex 3D movements in a confined space (right).



injection

ENGEL

visit to our customers A visit to our customers A visit to our customers A visit to our customers

is also No. 2 in the market for bumpers, of which around 35,000 are produced daily.

Plastic Omnium has been operating in Slovakia since 2001. Its main aim in establishing this branch factory was to supply parts to the Volkswagen factory in Bratislava.

Volkswagen set up its production plant in Slovakia in 1991 and is currently producing the car models VW Polo, VW Touareg, Porsche Cayenne and Audi Q7. For the VW Polo, Plastic Omnium delivers front and rear bumper units – painted to order – directly to the assembly line on a just-in-time basis. Complete front and rear modules for the SUV models Touareg/Cayenne/Q7 – likewise painted in the specified colours – are supplied on the same basis. “We are allowed a reaction time of exactly 287 minutes,” says works manager Vladimir Smolka, as he takes us on a guided tour of the factory. “In that time we must prepare the specified items for delivery and then transport them 20 km by truck to the plant in Bratislava. One big logistical problem is the large number of variants, especially in the case of the front modules. For the Porsche Cayenne, for example, we must be able to deliver any of 350 different modules. We solve the problem by keeping a large enough stock of all individual parts for three days’ production, which naturally costs us a lot of time and effort.”

Further car body parts include front end modules (structural components between the bodywork and the bumper unit) that are either produced as metal/plastic composites or moulded in a long fibre-reinforced plastic. Just-in-time deliveries over longer distances are planned for 2008. Painted front and rear bumper modules will be supplied to the Peugeot plant in Trnava, a good 70 km away, and even to the Skoda plant in Kvasiny, which will mean covering a distance of 234 km within the specified reaction time – a daunting challenge indeed.

For the production of these large car body components, Plastic Omnium uses nothing but machines from Engel, all of them ENGEL

DUOs. Eight machines are currently in service: two DUOs 11050/1100, five DUOs 23050/2300 and one DUO 35050/3200. The enormous number of different components currently necessitates the use of 53 injection moulds.

In order to keep mould changing times as short as possible, all moulds have been adapted for mould change by means of overhead crane, much of the changing process being automatic. The adaptations comprise mould guide-in systems, quick-action mountings and quick-release hose couplings, making mould change possible within around 20 minutes. The moulded parts are demoulded and handled by linear robots.

Small parts are not produced, but outsourced. Downstream of the injection moulding shop are the painting shop and a large assembly shop. With a total work force of around 400, Plastic Omnium in Lozorno is a company that cannot fail to impress – through its technical efficiency, its networking potential and its ample capacity for development, not least in Lozorno itself. <<



Plastic Omnium – Works manager Vladimir Smolka (right) shows Mastex sales manager Martin Janco front modules for Porsche and VW. Photos on right: Eight ENGEL DUOs producing large car body components (top). – All injection moulds are adapted for fast change by means of overhead crane (middle). – Front modules waiting for just-in-time delivery to VW in Bratislava (bottom).

big mover

2

Plastic Omnium/Lozorno Body parts from a global player

>> Not more than 20 km north-west of Bratislava is our next destination, the Plastic Omnium Industrial Park on the outskirts of Lozorno. We are visiting Plastic Omnium Auto Exteriors s.r.o., the local branch factory of the French company Plastic Omnium, a global player with 110 production facilities in 25 countries on four continents, a work force of 9,500 employees and a turnover of around EUR 2.2 billion, of which automobile components account for as much as 85 %. Plastic Omnium (www.plasticomnium.com) leads the market for plastic mudguards and other body parts, as well as complete front and rear modules. It

This restructuring programme was completed in 2005. Two further large-capacity machines with clamping forces of 18,000 and 23,000 kN respectively are planned for 2007. The existing production area of 9,300 m² will then be fully utilized. In its new structure, the production facility employs around 300 people, most of them working a three-shift system.

The change from an assembling facility to an injection moulding shop also led to a marked change in customer structure. Whereas in the beginning its main customers came from the electrical engineering and electronics industries, this Slovakian company’s customers are now mainly suppliers serving the automotive industry (firms of Tier 1 status, such as Faurecia, Delphi and Lear).

And it is precisely in this field that Fremach scores points with its special processing technologies. As many as 14 injection moulding



Fremach – Equipped for a wide scope of applications (the top photo shows injection moulding machines with clamping forces up to 3,500 kN, the bottom left photo shows one of the two large-capacity machines), Fremach specializes in component assemblies for car interiors. Bottom right: Works manager Koen Scherrens (right) shows Mastex sales manager Martin Janco one of Fremach’s numerous “Gasmelt parts”.



machines, for example, are equipped for the Gasmelt process. Two high-pressure compressors feed two central gas supply systems. This gas-assisted injection moulding process is used in applications that demand a high quality of surface finish, e.g. passenger compartment trim, glove compartments and centre consoles, and also television housings.

A further speciality is the production of large parts, such as the wheel arch shells that Fremach supplies as a Tier 1 manufacturer to Volkswagen/Bratislava and Skoda/Mlada Boleslav. Other large parts include the housing frames of plasma and LCD television sets – increasing in size from model to model – supplied to a number of TV manufacturers, including Samsung in Galanta in southern Slovakia, as well as paper drawers and toner containers for Xerox copiers.

On 1st January 2007, Punch International sold the Slovakian production facility to another Belgian company, Fremach N.V. Besides its parent factory in Diepenbeek/

Belgium, Fremach has a production site in Kromeriz/Moravia and a toolmaking facility in Helmond/Netherlands. Fremach’s main business is the production of surface-designed control panels for such car components as air conditioning systems, radios, steering wheel control interfaces etc., as well as remote control housings for electronic equipment and housings for tannoy systems, cash dispensers and measuring instruments. Its acquisition of the factory in Trnava represented a perfect opportunity to extend its production range. The parts produced in Trnava are largely of the same kind, that is to say, parts with high-quality surface finishes, mostly painted and/or printed.

“Fremach Trnava sees itself more and more as a manufacturer of components positioned relatively high up in the integration chain, a good example being the glove compartment assembly supplied to the KIA factory in Zilina for the KIA Cee’d. It is this system competence that we aim to strengthen in future, as well as our potential as suppliers of large moulded parts,” says Fremach’s works manager Koen Scherrens, a Belgian who has been working in Slovakia for almost ten years. With a Slovakian wife, he is also well integrated into the Slovakian way of life. Still on the subject of the company’s future, he adds: “We shall continue to build on Engel machine and automation technology.”

The eventful history of Fremach Trnava s.r.o. is an apt example of the generally necessary strategy of adaptation to the rapidly changing conditions of a booming economy in a still “young” EU member country. <<





JIT Plastic – A “start-up” company that equipped itself in 2006 with Engel DUO machines for the manufacture and JIT delivery of high-grade headlamp housings. As further products are in the pipeline, production capacity will be increased accordingly by the end of this year.



5 SAM Holding/Myjava Like a phoenix from the ashes

>> On our way to SAM Holding a.s. (www.sam-holding.sk), we take the motorway northwards out of Bratislava and the Danube Plain and drive a good 115 km, past Trnava, before exiting at the famous spa of Piestany. Small winding roads then take us through picturesque hilly countryside that suddenly opens out to reveal the industrial town of Myjava, on the outskirts of which we enter an industrial complex that clearly evidences the changes that have taken place here during the last fifteen years. What used to be a vast industrial area dominated by just one single manufacturing enterprise is now occupied by many freshly renovated buildings all bearing different company names and logos.

But these changes cannot be properly understood without a brief retrospective glance into the past. Originating from a number of different firms, SAM A.G. – the abbreviation SAM stands for “Slovakian Fittings Works” – was established as early as 1950. Within the planned economy of the COMECON countries, SAM operated as the sole supplier of water and sanitary fittings. In its peak years, SAM supplied a range of good-quality products to countries as far afield as the USSR. By 1989, the year in which communism collapsed, SAM had a work force of around 5,500. SAM’s employees today number 200.

The processing of metals – above all brass and aluminium alloys – was the starting point. Plastics processing began in 1955 with the introduction of plunger injection moulding machines of Czech manufacture. The expen-

4 JIT Plastic/Nové Mesto nad Váhom The name says it all

>> Nové Mesto nad Váhom, a small town about 100 km north-east of Bratislava, is our next port of call. To be more exact, our destination is a closed-down concrete factory on a main road on the outskirts of the town. At first glance nothing tells us that this is the home of a dynamic, up-and-coming supplier to the automotive industry. But our way to the managing director’s sparsely furnished office takes us through the newly adapted production shop, where two new ENGEL DUOs 4550/650 and one DUO 7050/900 are producing car headlamp housings of a wide variety of types and sizes. These complex parts are demoulded by robots, inspected by the machine operators, finished downstream and then deposited in transit containers.

We are impressed. Managing director Martin Makara and his deputy Peter Ganobcik, who is also the sales manager, proudly tell us that JIT Plastic is a classic start-up company that was quick to grasp the new opportunities afforded by the investments of the international automotive industry in Slovakia. The history of the company and the idea behind it are quickly told. Indeed, it is those very simple yet logical ideas that more often than not lead to success. Like the four other co-founders of the company, Martin Makara, a trained engineer, had gained vast experience in various positions with industrial firms. Standing him in good stead above all else were his ten years as Development Engineer and Technical Director with a Magna Division. It was during that time that he was able to acquire a comprehensive knowledge of the automotive supply industry. He knew, for example, that Hella Slovakia Front Lighting s.r.o. in the neighbouring town of Kocovce did not have a supplier of headlamp housings

in Slovakia, and so, at the beginning of 1975, he approached Hella with the offer to supply them – a courageous step to take, but one which, in the final analysis, was altogether logical. As Hella did not wish to warehouse the housings, it was necessary to draft a just-in-time concept. The logistical prerequisites could be readily satisfied, as Hella’s factory was only 5 km away from the production shop in the aforementioned concrete factory. Two hours’ delivery was stipulated in the contract, which was drawn up initially for a minimum period of four years – enough time to ensure the repayments on the loan for the first capital investments. The nature of the contract also gave the company its name: “Just-in-time Plastic” – or JIT Plastic for short. The name says it all.

Martin Makara and his co-founders first had to set about adapting and equipping the

production shop. A decision had to be taken concerning the choice of suitable injection moulding machines. “Of course,” says Martin Makara, “we considered all possible variants, including used machines and new machines from Asia, but in view of the standard of quality laid down in our contract with Hella, we finally decided in favour of new machines from Europe. From a shortlist of three – two German firms and Engel – we finally chose Engel, not just on account of the technical specifications but also because of Engel’s good reputation and Engel’s local presence – that’s what clinched our decision. We have not regretted this decision either, and our success has proved us right. Being able to keep all our delivery promises has brought us more business, so much, in fact, that we are already having to expand our production capacity.” A further ENGEL DUO 7050/900 WP will be delivered in March 2007.

As we toured the factory, much mention was made of the company’s plans for expansion and the potential afforded by the existing grounds. The just-in-time concept is also to be implemented for customers located further afield. The necessary warehousing facilities and a kanban logistic system have already been installed. It is also planned to take on additional assembly work, thus further increasing value creation. All in all, JIT Plastic is the perfect example of how opportunities in a free market can be readily grasped through initiative and courageous entrepreneurial spirit. We wish this young company every success for many years to come. <<



JIT Plastic – the team of young company co-founders (from left to right): production engineer Jaroslav Potfaj, sales manager Peter Ganobcik, production logistics manager Jaroslav Noskovic, managing director Martin Makara, SAP coordinator Marek Dubovy, Mastex sales manager Martin Janco and quality assurance manager Pavol Predny.

Training centre opened in Slovakia

>> Engel’s business with firms in Czechoslovakia goes back as far as the 1950s. When the country was divided into two independent states, so, too, was the market for injection moulding machines. The market of the Czech Republic is handled by Engel’s subsidiary in that country, Engel Czech Republic, while the Slovakian market has been in the care of Engel’s sales agents, Mastex s.a., Bratislava, since 1991. Mastex currently serves almost 80 Engel customers, who together operate over 580 machines. In order to cope with the rapid growth of the injection moulding industry, above all among automotive suppliers, Mastex has now opened a training centre for machine operators and maintenance engineers. All current Engel training courses have been held in Slovakia at Mastex’s Senec branch since autumn 2006. It is planned to complement the theoretical courses with practical training on demonstration machines before the end of 2007. <<



JIT Plastic – The company offers not only injection moulded parts but also pre-assembly. Shown here, for example, is the fitting of cable entries and other inserts to headlamp housings.



1: Bratislava – Mastex’s headquarters, 2: Senec – trainings centre and replacement parts warehouse, 3: Snina – service office, 4: Zilina – service office, 5: Nitra - service office



TESLA – General manager Daniel Roth gives us an insight into the impressive turn-around of the formerly state-owned, now privatized company.



SAM Holding – A total of 84 injection moulding machines – 47 of them from Engel – produce a wide range of sanitary products. Photo on right: several older Engel machines are still in daily use thanks to excellent maintenance (see also report on page 11).

sive brass components were then gradually replaced by thermoset and, later, thermoplastic parts.

As everywhere in Europe, the 1960s saw a rapid growth in the injection moulding of plastics, which increased still further during the 1970s. It was during these years of economic upswing that SAM grew not only as a manufacturer of fittings but also as an important supplier of parts to various industries, including programme control cams for washing machines, housing components for television sets and computers and drawers and receptacles for refrigerators. In peak times during the 1970s, SAM processed around 6,500 tonnes of plastic per year.

Collaboration with Engel began as early as 1963, when the first West European injection moulding machine – an ESMA-Sch 200/400 – could be purchased through the responsible foreign trade organization in Prague. Eight further Engel injection machines followed in 1965

and 1967, but the big breakthrough came in 1969, when an order was placed with Engel for 52 machines with clamping forces ranging from 150 to 7,500 kN. Now equipped with a total of 62 machines, SAM had grown virtually overnight to become Engel's biggest customer in Czechoslovakia. Plans to annex an Engel injection moulding training centre to the SAM production facility were thwarted by the political intransigence that prevailed in those days. With almost 100 machines at its disposal, SAM's injection moulding capacity was among the largest in Eastern Europe. A further 12 Engel machines were ordered at relatively large intervals during the years up to 1989, some of them as replacements for older machines, others as additions to existing capacity.

The political changes of 1989 also brought about a collapse of the COMECON market. The age of monopoly enterprises that supplied fixed quantities at predetermined prices was now over. With the introduction of a free mar-

ket economy, the old, inflexible large-scale enterprises had no chance of survival. The logical consequences were a downsizing of production, a reduction of the work force and the search for new customers. SAM a.s. was divided up into smaller divisions. One of them was SAMPLAST a.s., which, after being taken over by a Slovakian financial investor, became what is now SAM Holding a.s. The metal fittings production facility could not be sold and had to be closed. Other areas of production that were no longer required were sold to foreign companies. A further change also coincided with this "rebirth" of the company, namely the founding of Slovakia on 1st January 1993.

In spite of all adversities, SAM Holding had a successful new beginning, thanks not least to the dedication of its core personnel. With its aforementioned team of 200 employees, SAM concentrates on the injection moulding of plastics, achieving an annual turnover of

around 6 million euros. As much as 70% of this turnover is achieved with SAM's own range of sanitary products, which are exported not only to its existing customers in the neighbouring countries of eastern Europe but also to western Europe. General industrial products account for 25 % of production, the remainder comprises a wide variety of household products, e.g. toilet cabinets, transport boxes, garden sprayers and carpet cleaners. Machines are renewed gradually, as and when finances permit. As many as 12 machines have been purchased since 1990, for example. Of a total of 84 machines currently in service, 47 are from Engel – that's 56%. The amount of plastic material consumed is likewise increasing again and was over 2,000 tonnes in 2006. More and more prominent names now count among SAM's customers. Thus SAM Holding is rising again like the proverbial phoenix from the ashes – though much has yet to be done before it can fly again. <<

6

TESLA/Stropkov Back to the future

>> The last stage of our journey takes us through north-eastern Slovakia, the mountainous region of the Low Tatra with its numerous skiing resorts, past the almost 3,000 m high mountains of the High Tatra, to Stropkov, the central town of the region with a population of 11,000 inhabitants. After a good five hours' drive, we finally reach our destination. It is the largest firm in the region: TESLA Stropkov a.s. (www.tesla.sk). "TESLA" – the huge letters on the office building can be read from afar – stands for *TE*chnika *SL*abobruďa, the Slovakian words for "light current engineering" – and also for the American engineer of Croatian birth, Nicola Tesla, the inventor of the most important systems for the application of alternating current.

Having been formed in 1946 from a union of several electrical engineering companies, some of which could look back on a very long tradition, TESLA grew to become a state-owned concern with more than 70 factories and around 12,300 employees – the Czechoslovakian equivalent of a group the size of Siemens. Its vast manufacturing range includes radios, television sets, transmitters and telephones. The Slovakian TESLA factory in Stropkov was established in 1960 as part of the TESLA Investment Electronic Division within the scope of an industrialization programme for Slovakia. The factory acquired independent status within the organization in 1980. At that time it was producing a whole range of telephone and telecommunication systems, some of which are still being produced today.

The collapse of the communist system in 1989 brought with it a dissolution of the state-regulated economy. TESLA STROPKOV was converted into a state-owned joint stock company. Naturally, this did not solve its ever increasing economic problems caused by its

– mostly eastern European – trading partners' defaults in payment. Alternative forms of business dealing based on barter agreements created more problems than solutions. By 1993/94, the factory was facing economic ruin and the fate of 1,500 employees was hanging in the balance. A solution just had to be found.

The alternatives were either to close the factory or to privatize it and make a fresh start. But who would be prepared to buy a factory that was much too large for the changed circumstances? And so it was that a group of 16 members of the managerial staff, led by automation engineer Daniel Roth, plucked up enough courage to take out a loan and buy the factory themselves. "We are the kind of community that sticks together," says Daniel Roth, now general manager. "All 16 of us are still here after 12 years. Every crown we have earned since we started has been invested in the company. After all, we owe it to the remaining 900 employees and their families who stood by us." Chief technologist Peter Sabol adds: "A new beginning was made possible by our quality certification from Volkswagen, which we finally obtained after several attempts and with enormous effort. Since 2001 we have been producing a whole range of electrical connectors for the Volkswagen Group – 24 hours non-stop. And as our other production departments – such as toolmaking, cable harness assembly, telephone construction – are now doing more business in new products and/or competing well as contract manufacturers, we are slowly earning money again and can now set about renewing our machines and equipment."

TESLA STROPKOV is one of two factories of the TESLA Group in Slovakia that have survived the change from the old to the new. TESLA satisfies the prerequisites for business on an international scale not only because it meets all the important quality requirements but also because it can draw on the many



TESLA – Technically demanding metal/plastic composites for the automotive industry are the potential for the successful future of this large-scale supplier of telecommunication components.

years' experience of its employees. The injection moulding shop is currently equipped with 67 machines. Most of them are still of Czechoslovakian manufacture (TOS Rakovnik and CS Vihorlat Snina), but TESLA has also been investing in new Engel machines in parallel with each new project for the supply of automotive components.

As many as 22 ENGEL VICTORY machines ranging from 800 to 6,000 kN clamping force are in service at TESLA. The most recent addition is an ENGEL INSERT 200/60 for the in-line encapsulation of contact boards with plastic plug housings. Asked why TESLA

chose Engel, Daniel Roth replies: "We always appreciated the fact that in all the years we were still not in good shape financially we received regular visits from Engel's agent in Bratislava, which is 480 km away, and will continue to receive them. Most of our potential suppliers give up after the first visit and expect us to come to Bratislava." This perfectly sums up the situation as a whole. Without their enormous dedication and their belief in their own capabilities, the TESLA team would never have survived in this remote region of northern Slovakia. And the results are pointing the way forward. The future is back in reach. <<



Mass production of the two-component covers for the Lambda probe plug-in connector at Bosch in Waiblingen – naturally fully automated and unattended (left). The production cell for the two-component PA/LSR composite is just one of several Engel LIM machines in this production line (right).

Bosch Kunststofftechnik, Waiblingen/Germany Competent in complexities

>> "To fulfil the strict emissions norms in California, the Swedish manufacturer Volvo equipped its export models with Lambda probes from Bosch. In 1976, Bosch only produced a few probes a day. Today, 69,000 leave the main factory in Rutesheim, Baden-Württemberg, every day." This is the information we found on Bosch's website (www.bosch.com) as we began to research into the 30 years' success story of this company's emission-reducing "oxygen sensor". First used in a standard passenger car in 1976, this Bosch development transformed uncontrolled catalytic converters into controlled three-way catalytic converters for all petrol-driven cars.

Like many engine and engine compartment components, the Lambda probe could not be made today without the use of plastic parts. These parts are produced by Bosch in its "Plastics Technology Competence Centre" at Waiblingen. With over 1,300 employees and a good 250 injection moulding machines, the Waiblingen facility produces not only conventional parts in engineering plastics but also

The Elastomer Group of Bosch Kunststofftechnik in Waiblingen specializes in the injection moulding of elastomer parts and two-component rigid/flexible composites for high-tech automotive applications. Parts of reproducibly high quality are being efficiently mass produced on automated Engel Elast injection moulding machines.

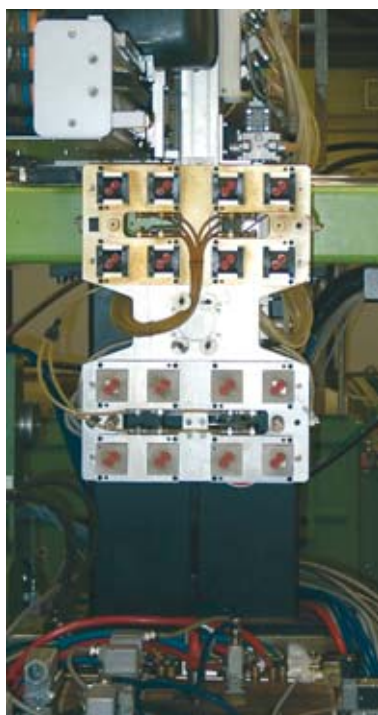
elastomer and two-component parts, the latter mainly consisting of thermoplastic/silicone composites. These composites are used both in plug-in connections and in engine components. Thus the 70 or so employees of the "Elastomer Group" are forever faced with challenging problems, the following examples being only two of many.

Two-component cover for Lambda probe connector

The electronic circuitry of the Lambda probe must be reliably and permanently protected against the ingress of dirt, oil, splashed water and creeping moisture – no easy task considering the conditions that normally prevail in an engine compartment. To this end, Bosch developed a hermetically sealed two-component cover with an integrally moulded silicone seal. As this cover also serves to protect the circuitry throughout every stage of production, including transport, it first takes the form of a readily detachable part.

The main body of the connector is injection moulded separately as a single-component part. This main body and the two-component cover are then loosely pre-assembled in readiness for circuit assembly and wiring. The connector is then transported to the actual Lambda probe production facility in Rutesheim. Once the electronic circuitry has been checked and adjusted, the connector is permanently locked and hermetically sealed with the aid of non-detachable clips.

The cover is injection moulded in an 8+8-cavity two-component mould in one production process. The main body of the cover, moulded in a heat-stabilized, high temperature resistant PA 66, is transferred by robot to the second station for



Tiebarless Engel machines afford plenty of space both for the mould and for the parts removal robot, like this Bosch-built 8+8-cavity gripper head (shown here in its waiting position above the still closed mould).



The two-component cover with integrally moulded seal (red) permanently protects the electronic circuitry against ingress of contaminants – a basic prerequisite for the reliable operation of the Lambda probe during the lifetime of a car.

the application and vulcanizing of the LSR seal. Both components are produced without any sprue waste. The PA is injected via a hot 8-runner feed system and the LSR via a cold 8-runner feed system.

Despite this component's apparent simplicity, much development work had to be done before mass production was running smoothly. The geometry of the cover had to be so optimized that sliding splits could be waived, thus reducing the platen area needed. A further problem was the adhesion of the LSR on the heat-stabilized PA. This problem was resolved partly by optimizing the geometry and partly by optimizing the process control.

In spite of the machine's high long-term performance rating, each of the eight covers is inspected individually – in a testing station (from Bosch) equipped with a camera system – before the Engel demoulding robot stacks them in cavity pattern formation.

The machine used is a horizontal, tiebarless ENGEL VICTORY 200H/200L/125 Combi (1,250 kN clamping force) equipped with one thermoplastic injection unit and one LIM injection unit plus an LIM metering system. The machine is served by an ENGEL ERC linear robot. The Waiblingen facility already has three such machines in permanent operation – two with 1,250 kN clamping force and one with 1,500 kN clamping force.

Armature for canister purge valve

Fuel retention systems prevent emissions caused by the evaporation of fuel from escaping to the ambient air. An active carbon filter captures the fuel vapours. When the engine is running, these vapours are

mixed with the intake air via the vacuum in the intake manifold. "Canister purge valves" control the flow of air through the active carbon filter independently of the engine's operating state.

The nucleus of any canister purge valve is the armature that controls the air flow. It is an extremely robust metal/silicone composite and is rated for up to 400 million duty cycles! The mechanical load, especially on the silicone membrane and the damping elements, is enormous. Added to this load is the chemical load caused by the fuel.

The injection of the silicone into the 16-cavity mould is an extremely delicate process. For absolutely flash-free and waste-free moulding, the mould has a cold runner system with 48 nozzles (three nozzles for each of the 16 metal plates). The machine is a vertical ENGEL ELAST 100V 2F (1,000 kN clamping force) equipped with two solid silicone injection units (arranged vertically and horizontally). The armatures are currently being produced by Bosch on two such machines in quantities of several million per year.

Competent partnership

With such complex demands on the parts and their function, any "off the peg" injection moulding machine would soon reach its limits. For such applications, close cooperation between the user and the manufacturer of the injection moulding machine is called for. When it comes to the injection moulding of elastomers, Bosch has a competent project and service partner in "SI Industrievertretung" in Remseck, the local agent for Engel Elast machines.

Bosch also appreciates Engel as a supplier of machines and equipment for all injection moulding applications, from thermoplastic elastomer, and up to the highest degree of automation. Besides LIM machines, vertical Elast machines and two-component machines for rigid/flexible composites, the Waiblingen facility also operates a large number of tiebarless Engel machines for thermoplastics. <<



Armature (bottom left) for canister purge valve: the red silicone membrane must withstand enormous mechanical stress; the brownish-grey silicone projections on the outside perform a dampening function during the switching cycles of the armature.

injection

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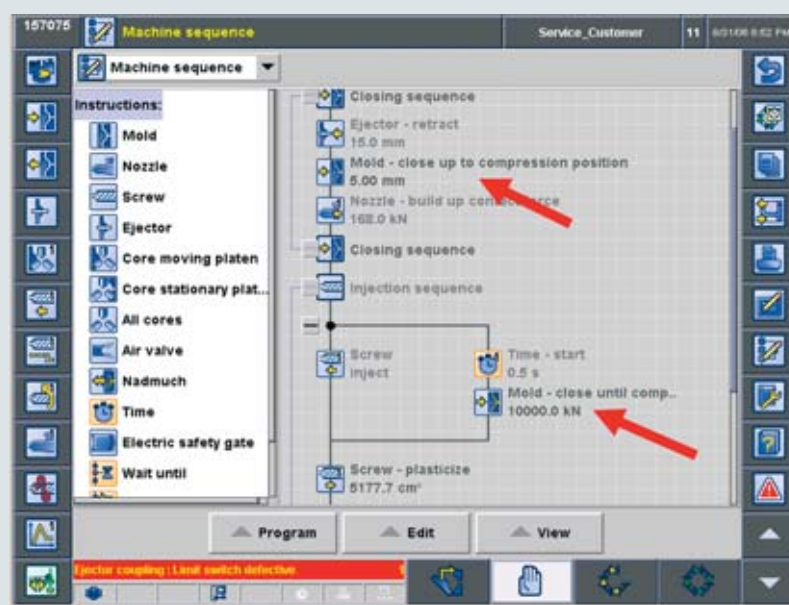


Injection-compression moulding Made-to-measure modules

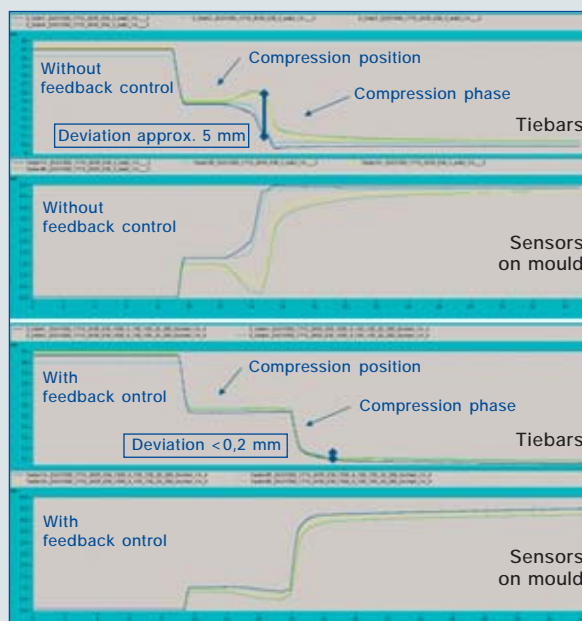
BASIC – PROFI – EXPERT – TECOMELT – these are Engel’s four modules tailored to the requirements of injection-compression moulding. Graded according to performance, these modules together represent the state-of-the-art technology for all injection-compression moulding processes in use today.

		Precision opening of mould with platen parallelism feedback control
EXPERT	PROFI	Mould parallelism measurement Platen parallelism control during compression phase Tiebar elongation compensation for measurement and control Platen position and parallelism control during injection phase Wall thickness correction (deliberate misalignment)
		Basic injection-compression equipment package 3-step speed profile (CC200: 5-step) 3-step pressure profile (CC200: 5-step) Screw position feedback control (on machines with servo-valve for injection) Parallel injection/compr. without accu (red. speed for injection and compression) Parallel injection/compression with accu (injection with accumulator)
TECOMELT	PROFI	Compression stroke extension up to 100 mm (depending on mould height) 3-step reduction in clamping force after end of compression phase Program: Preshape fabric Program: Partial opening of mould Clamping frame function with proportional pressure control valve Change-over to holding pressure – cavity pressure-dependent

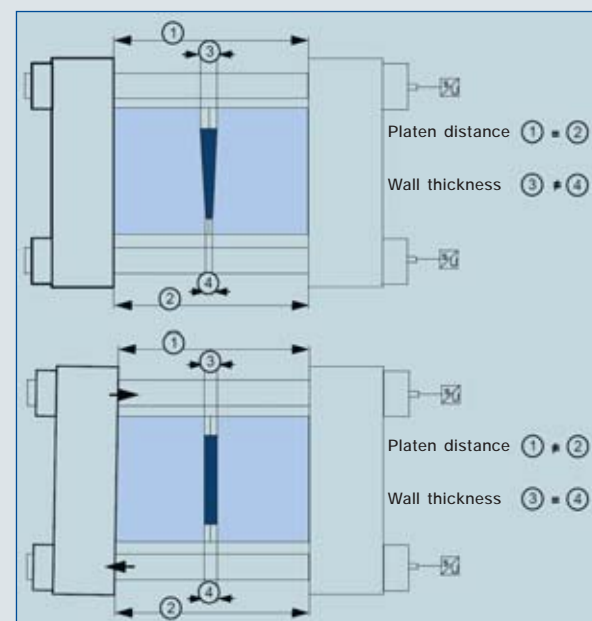
The “Basic”, “Profi” and “Expert” modules offer related performance features at three different levels, while “Tecomelt” includes the performance features of the “Profi” module plus the necessary functions for the back injection moulding of decorative materials. With the exception of “Expert”, which is available only for the new CC200 control system, all other module programs can be run on both the CC200 and the CC100.



The necessary operating sequences for the injection-compression moulding process can be readily integrated into the machine control system. This example shows the sequence for “parallel operation” using the “Basic” module, this being particularly easy with the touchscreen programming facility of the CC200 control.



PROFI: The “platen parallelism feedback control” ensures absolute parallelism of the platens throughout the entire moulding cycle (in this example, the additional sensors on the mould are no longer necessary).



PROFI: With the “wall thickness correcting facility”, any uneven wall thickness due to the configuration of either the mould or the part (top) can be compensated by the “deliberate misalignment” of the moving platen (bottom).

>> The injection-compression moulding process is a modified form of injection moulding for the economical production of relatively stress-free plastic parts. The melt is injected into a partially opened mould and is therefore virtually unpressurized. Upon completion of the injection process (sequential operation) – or even during the injection process (parallel operation) – the mould closes under increasing clamping force and the melt completely fills the mould cavity. In another variant of the process, the cavity is completely filled with melt and then the mould opens a controlled distance under increasing cavity pressure. This variant is used, for example, in the manufacture of data carriers (CDs, DVDs) with surface structures or, in a similar form, for the production of large-size, low-stress car windows in polycarbonate (PC). With all polymers, injection-compression moulding produces parts featuring a very good surface finish and negligible mechanical anisotropy (differences of property in different directions of measurement).

The main advantages of injection-compression moulding are:
>> Lower injection pressure requirement;
>> Negligible shear stresses in the melt and a homogeneous holding pressure profile result in negligible internal stresses in the moulded part;
>> The lower clamping force requirement may even permit the use of a smaller injection moulding machine (cost saving);
>> The machine can also be readily used for conventional injection moulding.

Of course, every advantage has its disadvantages:
>> Process control is considerably more complicated than in the case of “simple” injection moulding, making the machine (given the same clamping force) more expensive;
>> The injection-compression mould is more complex, as it must take the form of a positive or frame mould.

To enable the processor to explore the “world of injection-compression moulding” as easily and as systematically as possible, Engel has developed a series of injection-compression modules tailored exactly to practical requirements.

High-performance modules for practical application

>> **BASIC:** When it comes to “straightforward” injection-compression moulding, i.e. the moulding of symmetrical and, more importantly, centrally gated parts (with uniform distribution of pressure in the cavity), the BASIC module affords the processor all the scope he needs (see overview). The software package can be used basically for all Engel machines. However, if the injection and compression operations are to run parallel, it is advisable to equip the machine with a hydraulic accumulator.

>> **PROFI:** The PROFI module has been developed for more complex and more demanding processes. Only the two-platen injection moulding machines of the ENGEL DUO series are suitable for this level of application. The reason lies in the DUO’s platen parallelism feedback control that works in conjunction with the four pressure pads for the clamping force. This control monitors and corrects the parallelism of the platens to within 5/100 mm (see past “injection” reports on this). Without this correction, any eccentric injection of the melt – this being the case in most practical applications – would give rise to reproducibility problems (see graph at the bottom of this page). The control software also corrects tiebar elongation individually whenever different forces act on each of the four tiebars. This patented parallelism control waives the need to equip the mould with additional sensors that would only make the control system even more complex.

Engel has even integrated a further correction feature into the PROFI module. This is a wall thickness correcting facility that “deliberately” brings the moving platen out of parallel with the stationary platen (see diagram bottom right). This facility is important not only in cases of advanced mould wear but also, and in particular, in cases where large parts are to be moulded. Tests carried out with a 1 metre long, side-gated, injection-compression moulded window pane showed a difference in thickness of 0.2 mm between the ends of the pane, although the platen parallelism feedback control had been operative

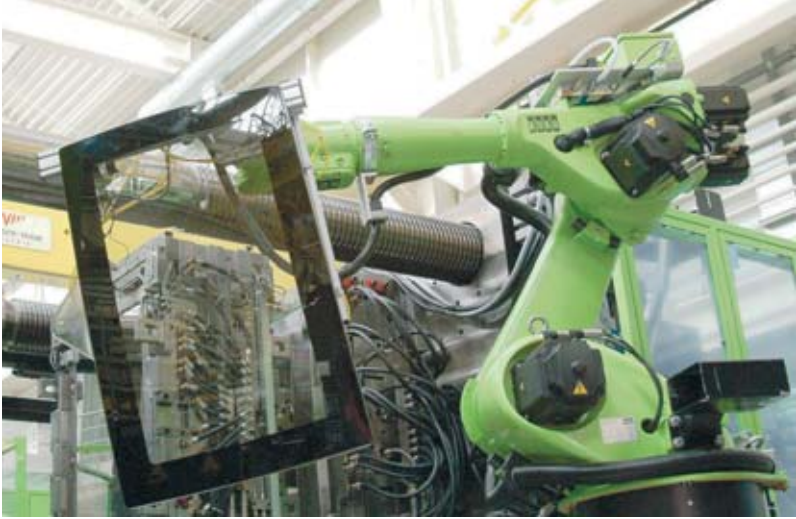
from the commencement of injection through to the end of the compression phase. Subsequent use of the wall thickness correcting facility reduced this difference to only 0.05 mm!

This deliberate out-of-parallel positioning of the platens does not in any way adversely affect the long-term performance of the DUO, as it still comes well within the tolerances specified in Euromap standard 9 for platen parallelism. The high resolution of the measuring system used by Engel does however enable the processor to utilize this tolerance range consistently and reproducibly for the sake of improved product quality.

>> **EXPERT:** In addition to the performance features of the PROFI module, the EXPERT module is equipped for “precision opening with platen parallelism control”. This controlled opening of the mould cavity is important not just in the case of solid parts that have to meet high standards of surface quality. It is absolutely essential for the production of foamed parts with solid, unfoamed skins: the foaming process does not commence until the completely filled mould cavity is enlarged through the retraction of the moving platen. An ideal example is the newly developed Dolphin Process for high-quality, soft-touch sandwich components for the automotive industry (see “injection 14”, p. 11).

Processors interested in EXPERT should note that the maximum speed of the compression phase is only half that of the PROFI module. The reason lies in the distribution of the hydraulic oil between the circuits for the forward and return movements of the moving platen and in the correspondingly more complex valve technology on the machine.

>> **TECOMELT:** This module likewise includes the performance features of the PROFI module plus the special functions required for the back injection moulding of fabrics, films and other decorative materials (Engel “Tecomelt” technology). <<



>> When planning a fully automated injection moulding cell, the choice of robot – linear or industrial – is of prime importance. But which type of robot is more suitable for the application? – The following comparison throws light on their differences and respective advantages and disadvantages:

Linear robots operate in a three-dimensional Cartesian space (hence also the term “Cartesian robot”) with defined coordinates. These robots have three independent main linear axes (X, Y, Z), which are in most cases servo-driven, the Y axis being additionally equipped with up to three pneumatically or electrically driven swivelling or rotating axes (A, B, C). Basically, linear robots >> are able to carry heavy loads over very long distances within a large working space, >> perform insert-placing and parts-removal operations quickly and with a high degree of positioning accuracy, >> permit automation at relatively low cost – three servo axes are generally sufficient for simple pick-and-place applications, >> can be integrated within the safety housing of the injection moulding machine (e.g. ER-HLi),

>> can be operated (programmed) comparatively easily and, in the case of ENGEL ERC linear robots, integrated into the machine control system.

Industrial robots, also known as articulated robots, can be equipped with up to six servo-driven axes, all of them rotational, and have a spherically defined working space. Industrial robots

>> can work in variable directions and are used both for universal and for even the most complicated applications, >> are capable of transmitting high forces and can even demould undercut parts, >> can be installed separately in order to reduce the overall height of the machine. This is advantageous, for example, in cases where a laminar flow box is located above the clamping unit (clean room application), >> are ideal for use with peripheral equipment and permit the integration of highly demanding tasks (e.g. assembling of parts) into the operating cycle of the machine, >> but industrial robots have one particular disadvantage in that their complexity demands a lot

Automation Industrial or linear robots?

There's a lot in favour of automated injection moulding: increased performance – greater flexibility – constant process stability – higher output of parts without loss of quality – integration of several functions in one operation. But which type of robot is the better choice – a linear robot or an industrial robot?



Linear robots – ideal for fast cycling machines

When it comes to automating an injection moulding cell, a combination of both types of robot is often the best solution. The linear robot takes care of the insert-placing and parts-removal operations and then hands them over to the industrial robot for downstream finishing and/or assembly.

In one respect, however, the linear robot is far superior to any industrial robot:

>> As the industrial robot must always move all six of its axes, even when moving its gripper head along just one axis, it can never achieve the speed of a linear robot.

It is for this reason that for fast cycling applications – for the production of packaging containers, for example – only linear robots are used.

When designing and equipping injection moulding cells, Engel's automation specialists always follow the same basic rule:

>> The choice of robot must be of maximum benefit for the actual application. <<



Linear robots on injection moulding machines for pick-and-place applications are a familiar picture (left) – but industrial robots, too, can be readily integrated inside the machine's safety housing for insert-placing and parts-removal tasks (right).



of expertise and experience from the programmer. One might easily assume from these brief descriptions that difficult tasks are best performed by the industrial robot. Is that in fact the case? Not necessarily, for much depends on the actual application. Here are two examples:

>> Production cell for multi-component parts, automated with a linear robot

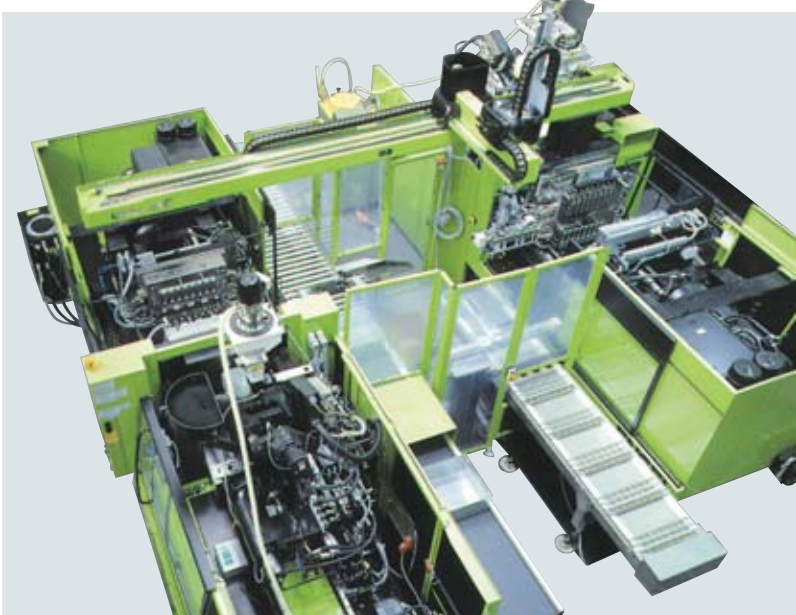
A production cell for a multi-component screwdriver consists of two two-component injection moulding machines linked by means of an ERC 63/2-C linear robot. The tiebarless machines are joined together not only mechanically – by a gantry – but also via a software package linking the two control systems.

Both injection moulding machines are equipped with an 8+8-cavity Combimelt mould. In the first machine, the screwdriver blades are placed in the cavities of station 1 and encapsulated with a handle core of PA. The parts are then transferred to station 2, where the handle cores are overmoulded with PP. The linear robot then transfers the semi-finished parts to the second machine, where the handle layers 3 and 4 are added.

>> Production cell for multi-component parts, automated with industrial robots

This production cell consists of two Engel injection moulding machines equipped for unattended operation. The parts are welding fittings for pipe systems. In the first stage, metal cores are placed in the cavities and encapsulated with the core material for the heating coils.

The parts are then transferred to the second machine for completion. Industrial robots have been selected for this application because many tasks have to be performed – sprue removal, fitting of the heating coils, functional tests, packaging of the finished parts – in addition to the actual placement, transfer and removal of the parts during the moulding cycles.



Production cell for multi-component screwdrivers: the blades are placed in the cavities by a linear robot. The four-component handles are moulded in four stages on two robot-linked injection moulding machines.



Where high speeds are required, linear robots are superior to industrial robots. A highly dynamic linear servo axis – as shown here – can today achieve speeds of around 10 m/s.



Production cell for pipe fittings with integrated heating coils: only industrial robots are capable of performing the complex additional tasks outside the two injection moulding machines.



Production cell with two Elast machines: the positions reserved for linear robots are occupied by brushing devices – insert-placing and parts-removal operations are performed by an industrial robot between the machines.

... "zero-time" demoulding?

Time is money – this goes for injection moulding in general and for the injection moulding of packagings in particular. With the "zero-time" demoulding system, a further development of the "Speedy" high-speed handling robot, it is now possible to minimize mould open times still further.



>> As "normal" linear robots are generally too slow for the demoulding of packagings on fast-cycling machines, Engel has developed the single-axis ENGEL ERS high-speed handling robot ("Speedy") for such applications. With an acceleration of 120 m/s² – that's more than 12 times the acceleration due to gravity – this highly dynamic servo axis is capable of speeds of up to 10 m/s.

However, fast speeds are not the only requirement when it comes to making the cycle time as short as possible. Equally important is the need to make all operations in the injection cycle run in parallel with each other if possible. Only these two factors together can give the shortest possible cycle times and hence maximum possible output. With a view to reducing or even avoiding "non-productive" times during the parts removal operation, the automation specialists at Engel have now developed the so-called zero-time demoulding system for the "Speedy" high-speed handling robot. The background:

With state-of-the-art demoulding systems, the introduction of the gripper unit into the open mould and its withdrawal from the mould after having taken hold of the parts always necessitate not only prior computation of the machine movements (starting, acceleration, deceleration, stopping) but also shot-by-shot plausibility checks. Moreover, this computation takes place sequential-

ly prior to each machine movement. For example, when the signal "Mould opened" is given (allowing the gripper unit to enter the mould), the movement of the gripper unit must first be computed before the handling operation can commence. The same goes for the withdrawal of the gripper unit with the demoulded parts and for the subsequent safety check once the robot has vacated the mould, so that the mould can close again without colliding with the robot. These "time losses" have now been rationalized by Engel's newly developed zero-time demoulding system. It works as follows:

>> When the signal "Mould open" is given, the robot immediately enters the mould and also immediately exits the mould after having taken hold of the parts. The robot then gives the signal to close the mould immediately it has vacated it. The benefit: shorter mould open time – shorter cycle time – higher output.

This advanced, "parallel" computation of the machine and robot movements was first made possible by the superior functionality of the Engel RC200 robot control system.

This further development of the ENGEL ERS will be available on the market by autumn of this year. The new "Speedy" generation will then be equipped as standard with the new zero-time demoulding system. <<

Superlatives for the Netherlands

>> Although the designing and building of large-capacity machines, both standard and customized, is the normal everyday business of Engel's factory at St. Valentin, there is always this or that project that can rank as a milestone in the company's history. One such project is the ENGEL DUO 75050/3200, which, together with an ENGEL ERC 123/1-E heavy-duty robot, was officially handed over to the Dutch pipe fittings manufacturer VDL (VAN DE LANDE B.V.) in Raamsdonksveer (near Breda) on 22nd February 2007.

Not just one but several superlatives make this project absolutely unique:

- >> The ENGEL DUO 75050/3200 is the largest PVC injection moulding machine ever to have been built by Engel,
- >> it has the largest PVC screw (245 mm diameter) known to exist with
- >> shot weights up to max. 70 kg PVC (through combined intrusion and injection moulding),
- >> and it is the largest Engel machine in the Netherlands.

The machine was purchased for the production of 500 mm diameter pipe fittings of varying type. VDL's production portfolio comprises bonded and threaded pipe fittings and pipe system components for pressure ratings of PN6, PN10 and PN16.



T.G.A. van de Lande (owner and managing director of VAN DE LANDE B.V., standing on the right) and Bas de Bruin (sales engineer, Engel Netherlands) on the "bridge" of Engel's hitherto largest PVC injection moulding machine.

With its 80 or so injection moulding machines – including 50 Engel machines, almost all of them tiebarless – VDL processes 70 % PVC and 30 % PE-HD. Following the trend to-

wards ever larger pipe diameters, the new machine will now enable VDL to offer fittings up to 500 mm diameter (the maximum possible diameter hitherto was 350 mm). <<

... and it's still going strong!



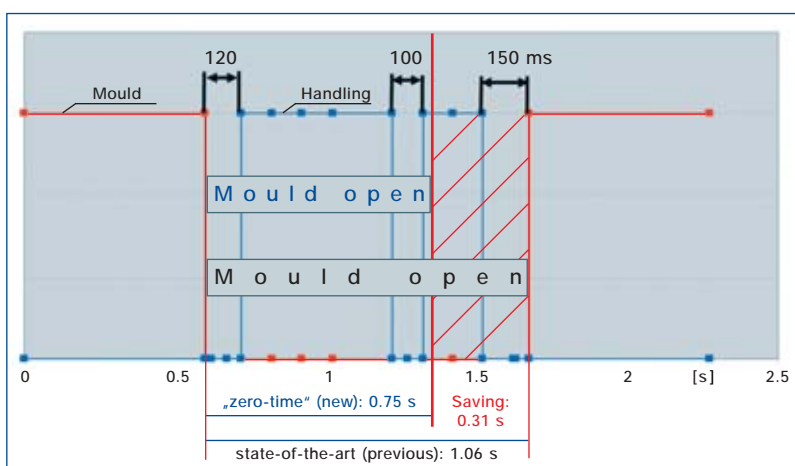
Group photograph with the operator of the 1963 Engel machine still in operation at SAM (from left to right): Pavol Siska, General Manager, SAM Holding, Reinhard Bauer, Editor Technokomm, and Martin Janco, Sales Manager, Mastex (Engel's sales agents in Slovakia).

>> Our research for our profile of Slovakia (see our report on pages 4 to 7) took us to several firms, including SAM Holding in Myjava, one of Engel's first customers in what used to be Czechoslovakia. It was there that we stumbled across a machine manufactured in 1963, which despite its "biblical" age of "two score years and four" was still producing sanitary components on a regular basis. This machine – an

Engel ESMA-Sch-200/400 ("Sch" stands for "screw", the alternative to the plunger injection system still offered in those days) – was the very first of a total of 86 Engel machines purchased by SAM Holding in the years that followed. As many as 47 of these machines are still being used for mass production applications. In fact, SAM Holding is the customer with the largest number of Engel machines in Slovakia.

General Manager Pavol Siska proudly tells us that it was on this very machine bearing the serial number 1538 that he began his career with the company as a machine operator (by comparison, the serial numbers of Engel's machines today start from 65,000!). It is not only this machine that is enjoying the best of health but also several others dating from those early years, both Engel machines and machines of Czechoslovakian origin. One of the reasons for this is the excellence of SAM's maintenance department, for it seems to have discovered the secret of eternal youth, at least with regard to the machines in its care. A quick tour of the factory bore this out: everything in top condition, not a single drop of leaking oil, hardly any damage to the paintwork – and not just the older machines, the younger ones, too.

Engel machines generally seem to be blessed with long life. We already reported some time ago ("injection 8") about a "contemporary" Engel ESMA-Sch 80/150 (serial number 1469) still in operation in an Austrian factory. And countless reports have also been received from other countries about similar "marathon machines" made by Engel. <<



The new "zero-time" demoulding system reduces mould open time: 120 ms (required computation time prior to gripper unit entering mould) + 100 ms (computation time prior to exit movement) + 150 ms (computation time after exit movement) = 370 ms altogether, of which 310 ms can be effectively utilized for shortening the mould open time. In this example showing an original (state-of-the-art) time requirement of 1.06 s, the time saving is a good 29 %.



Engel builds technology centre at Schwertberg

>> The ground breaking ceremony for one of the most important building projects in Engel's corporate history took place on 26th February 2006. This is the new building for a central technology centre at Schwertberg, the home of the Engel's parent factory. Four storeys (including basement) with a total floor area of 13,000 m² will accommodate six Engel departments –

Technical Development, Small and Medium-sized Machine Design, Quality Assurance, Engel Training Centre, Sales and Marketing and Human Resources – as well as an archive, storage rooms, restaurants for employees and visitors and a multipurpose event centre.

The technology centre will be built and occupied in two stages – by May 2008 and then by the summer of 2009.

The aim of this project is to re-structure and interlink development capacities, thus creating the necessary future-oriented prerequisites for the development of innovative injection moulding concepts and efficient machines, an aim expressed not least in the futuristic architecture of the new technology centre. <<



Further eastward expansion

>> With a market share of almost 40 percent, Engel injection moulding machines are the undisputed No. 1 in the growing markets of eastern Europe. Since 1989, Engel has been operating in these markets locally, initially through sales agencies and then gradually through its own sales and service companies, beginning with Engel Czech Republic (1990) and then Engel Hungary (1993) and Engel Poland (2002). In 2002, the "eastern network" was further enlarged with the establishment of Engel Finland, which also handles the markets of Estonia, Latvia and Lithuania.

The positive economic development following the entry of neighbouring countries into the European Union made further eastward expansion of Engel's sales and service network absolutely essential. Engel CZ moved into new and larger premises in Prague in September 2006. With a present work force

totalling 33, including 17 service engineers, and a comprehensive replacement parts warehouse, Engel CZ now counts among Engel's largest branch companies. Its training centre and its large technical service capacity qualifies it as a service centre capable of serving not just the market of the Czech Republic but also, when required, the entire economic region of central and eastern Europe. Engel Poland, too, has adapted to the growth of the market, investing in a new sales and service centre at the beginning of 2006 with the aim of being even better able to give its customers application-specific advice.

Further milestones along Engel's road eastwards followed in 2006 with the establishment of sales branches in Russia ("OOO ENGEL", Moscow) and Ukraine (ENGEL TOV, Kiev). With its own replacement parts warehouse and training centre as well as service engineers in the most important industrial regions (Samarra, Togliatti), Engel Moscow can now offer a quality of service that entirely does justice to Russia's economic development. The market in Russia's neighbouring country Belarus is handled by a sales office in Minsk, which works in close collaboration with Engel Ukraine.

Further eastward expansion will take place early in 2007 with the establishment of Engel Romania in Bucharest. <<



Over 100 Engel machines at Jász-Plasztik/Hungary

>> In less than 20 years, Jász-Plasztik Kft. in Jászberény, has become Hungary's leading plastics processor. The foundation was laid by garage mechanic Lajos Kásza with three home-made injection moulding machines. By 1990 the firm had moved into a building rented from Lajos Kásza's former employer, an agricultural co-operative, which he later took over entirely, as well as a former battery factory. Jász-Plasztik today produces parts for television sets and white goods. Three factories with 163 injection moulding machines (including 110 from Engel) with clamping forces ranging from 450 to 32,000 kN, a work force of 1,700 and an annual turnover of HUF 23 billion (approx. EUR 93 million) – that's the status quo, but further growth is in the pipeline. <<



At the celebration marking the delivery of the 100th new Engel machine on 21st March 2007, representatives from Engel thanked the founder of the company, Lajos Kásza, for the trust placed in Engel during the past 12 years. Present at the ceremony were (from left to right): Joachim Metzmacher (Works Manager Engel St. Valentin), Heinz Rasinger (Engel Sales Manager, St. Valentin), Albert Vincze (Branch Manager Engel Hungary), Christian Pum (CSO Engel), Lajos Kásza (Managing Director and Proprietor Jász-Plasztik), Erika Szilágyiné-László (Foreign Relations Coordinator Jász-Plasztik), Anikó Balogh (Financial Director Jász-Plasztik) and Jochen Wallmüller (Engel Sales Engineer, St. Valentin).

"Training Award in Gold" for ENGEL e-TRAINER

>> The ENGEL e-TRAINER[®], the "virtual" injection moulding machine that is meanwhile a successful and not least essential part of Engel's training program for machine operators recently won a highly coveted award. As one of the 20 finalists for the "International German Training Award 2007" organized by the BDVT (Professional Association for Sales Promoters and Trainers) in Cologne, Engel's training concept won the "Gold Trophy". The award ceremony was held in Cologne on 3rd March during this year's "Didacta", Europe's largest trade fair for education and training.



Carsten Stöltzing, Training Manager, Engel Germany, holding the "Gold Trophy" of the International German Training Award 2007.

Since 1992, this award has been presented annually by the BDVT to firms operating "professional seminars, workshops and training programs which:

- >> develop and promote personal or professional initiative,
- >> are strategically configured,
- >> take the interests of the participants into consideration and
- >> are able to motivate participants through a richly varied choice of inventive methods."

The contestants must also show that their entries enjoy successful application. – The "ENGEL e-TRAINER" meets all these criteria. <<

Irene Schwarz recognized for her lifetime achievements



Irene Schwarz is the first woman to become an Honorary Senator of the University of Leoben (from left to right): Dr. Peter Neumann, CEO Engel Holding, Georg Schwarz, CEO Engel KG, Dr. Walter Friesenbichler, Chairman of the Plastics Processing Institute, Irene Schwarz, Prof. Dr. Wolfhard Wegscheider, Rector of the University, Prof. Dr. Klaus Lederer, Plastics Chemistry, Dr. Alfred Lampl, CTO Engel (retired), and Prof. Dr. Reinhold Lang, Materials Science and Testing of Plastics.

>> On 15th December 2006, Irene Schwarz, co-owner of the Engel Group, was the first woman in the 167-year history of the University of Leoben/Austria to be awarded the title of "Honorary Senator". At the award ceremony, Professor Dr. Wolfhard Wegscheider, Rector of the University, praised Irene Schwarz's lifetime achievements for the plastics industry and her exemplary commitment to the development of the Engel Group as a global player. <<

Engel invites entries for "HL Award 2007"

>> Over 30,000 machines manufactured and delivered since 1989 testify to the success of the tiebarless concept and its advantages. Free access for mould changing operations, full utilization of the entire platen area, especially when working with large and/or awkwardly shaped moulds, and the much easier integration of automation equipment are just a few of the advantages:

>> The tiebarless clamping system affords users an extremely broad

scope for creative application and an enormous potential for economically efficient production.

The "Engel HL Award" – HL is the abbreviation of the German term for "tiebarless" – is Engel's regularly pre-



sented prize for particularly innovative applications of the tiebarless clamping system. The six best teams and their creative ideas are then presented at one of Engel's evening events. The three best concepts – Gold, Silver and Bronze – are shown in a film presentation. The HL Award ceremony for 2007 is planned for K 2007 in Düsseldorf. Entry application forms can be obtained from Engel's subsidiaries and agents. The deadline for the submission of entries is 31st July 2007. <<