

## „Engel Phoenix Project“: Stronger than ever ...

>> "Schwertberg, 12th August 2002: The floods in Upper Austria caused by the continuous and heavy downpours of the last seven days have also taken their toll of the parent factory of the injection moulding machine manufacturer Engel in Schwertberg, 20 km east of Linz. .... The floods have mainly affected the machining shop, which produces the metal components for the injection moulding machines. .... The floods occurred, very suddenly and unexpectedly, during the company's two weeks' annual holiday. Although the factory gates were not due to open again until the following Monday, 19th August, many Engel employees broke off their holiday in order to help with the clearing work once the water had subsided on 9th August. ..." - this was the wording of our first press release on the "Floods at Engel".



Just one example of many: The machining shop after the flood, from the outside...

Unfortunately the catastrophe was far from over. The second flood, which arrived during the night of 13th August, was even more devastating than the first one, at times reaching a height of over 2 metres as it gushed through Engel's factory at alarming speed. Once the situation could be appraised, the following information was released to the media: "... None of the company's employees came to any harm. The material damage, on the other hand, is enormous and has affected both our production machines and equipment and a large part of our infrastructure. ... 'We have not as yet been able to calculate the full extent of the damage,' said Dr. Peter Neumann, going on to say, with unbroken optimism: "We shall not only begin the repairs right away but also make this disaster an opportunity to rebuild and re-equip Engel Schwertberg even more in line with future needs. ..."



... and from the inside: the flood destroyed the production machines beyond all hope of repair.

What has happened since then? Has the proverbial phoenix risen from the ashes? Has Engel recovered from the devastation caused by the floods? Was it in fact a new beginning, the starting point for a comprehensive restructuring and improvement of Engel's production facility at Schwertberg?



The work of cleaning up begins. The mud must be cleared while it is still wet.

### Stage 1: Restoring output capacity as fast as possible

The top priority after the floods was to restore our output capacity as fast as possible so that promised delivery dates could be adhered to and a regular supply of replacement parts could be ensured. This we succeeded in doing within a very short time, thanks not least to the concerted efforts of all our employees – including those at our factories in St. Valentin, Dietach and Steyr – and to both our existing and our newly contracted suppliers. After only two or three months, our customers were hardly able to tell that Engel was just recovering from a flood disaster. Through flexible utilization of the production capacity of our factories at St. Valentin, Dietach and Steyr and the magnanimous co-operation of our suppliers, we were soon able to make up for the loss of production capacity at Schwertberg for the mechanical components of our small and medium-sized tiebarless injection moulding machines.



One of the walls of the machining shop had to be rebuilt and the walls ...



... have meanwhile been reclad, Once the interior had been cleared and refurbished ...



... the new production lines could be installed at the beginning of the new year.

### Stage 2: Nothing need be as it was before!

While Engel was still restoring its output capacity, plans were already being forged for the rebuilding of the production facility. In view of the extent of the damage, Engel had decided to "make a virtue of necessity". Everything came under review, the entire organization, all processes and procedures. One very visible result – and one which has already been achieved – is the merger of the three hitherto separate Austrian companies Engel Vertriebsgesellschaft, Engel Maschinenbau and Engel Automatisierungstechnik into one single company: ENGEL AUSTRIA GmbH. The effect of this merger has been to change the infrastructure such that the Schwertberg factory is now better able to mesh with the other facilities at St. Valentin, Dietach and Steyr.

Central to the restructuring project was the concept of the "technology competence centre". The St. Valentin facility, which manufactures Engel's large-capacity machines, is now the competence centre for all injection units, while the plasticizing units (including the cylinders) are the responsibility of the material experts at Steyr. Consequently, both of these production facilities will be extended. Work has already begun on the extension at Steyr – this is the factory's third extension since its inauguration in 1988 – and is scheduled for completion in April. Production in the new extension will commence in the summer of 2003.

The space gained at Schwertberg will help to increase the output capacity of the assembly department. As more than double the floor space will be available for application engineering, we can now offer our customers an optimum infrastructure for the development of their products in close and purposeful collaboration with Engel. The extension of our mould-making department at Schwertberg – it will soon be transferred to a new building only a mile away from the parent factory – will offer similar customer benefits. Not only will the new building accommodate a pilot plant equipped with machines for mould proving but the scope of Engel's mouldmaking services will also be extended to include rapid prototyping.

The aim of the restructuring project is not least to equip Engel's facility at Schwertberg with optimized methods and state-of-the-art machines – in order to meet the challenges of the future.

Even though the flood disaster dealt the Schwertberg factory a savage blow, Engel will not be left with any deep scars. On the contrary. Once the most important objectives of the "Engel Phoenix Project" have been achieved – by the summer of this year – Engel will be able to look to the future with the utmost confidence.

Indeed, Engel will emerge stronger than ever. This is proved not least by the fact that, after the money from the insurance and the government reconstruction fund has been used up, the company will be able to cover the remaining damage – amounting to a good EUR 40 million – from its own financial resources. <<

### In this edition



>> **Page 4:** Mehr Cam Pars, a supplier of automotive components in Tehran, is an impressive example of the rapid development of Iran's automotive industry in recent years.



>> **Page 5:** Three-dimensional and networked from start to finish: Engel's new mould making department is now equipped for even greater efficiency.



>> **Page 6:** ABB Energiekabel now uses an Engel three-component LSR injection moulding machine for the production of a composite cable fitting.



>> **Page 7:** The new R9 marathon non-return valve on the testbed – improved geometry strikes an optimum balance between reproducible closing action and long service life.

### Supplement

injection – North America

Dear Customers,

It is with the utmost gratitude and respect that I wish to take this opportunity, on behalf of the management and of all Engel employees, of thanking you for the spontaneous moral support which you gave us both during and since the flood disaster at our Schwertberg factory. We were at once delighted and enormously encouraged whenever a customer decided to place an order with us without at all being sure whether or when we would be able to deliver. And such a demonstration of loyalty and trust was by no means an isolated incident.

Our top priority was of course to restore our output capacity as quickly as possible. This we succeeded in doing with the aid of our existing and our newly contracted suppliers, to whom we likewise owe our grateful thanks. And our thanks also go to all the many people who came to our immediate rescue in the emergency, above all the soldiers of the Austrian Army and the firemen of the Volunteer Fire Brigades who worked to the very point of exhaustion.

When faced with the problem of repairing enormous damage in the wake of a natural disaster, any company will naturally ask itself whether it is desirable or feasible to keep the same site or move elsewhere. Engel has decided to "stay put" and to continue production at the parent factory in Schwertberg, a site which has played such an important rôle in the history of the company. This decision was naturally facilitated by a state-subsidized flood protection project which will embrace not only our factory but also the surrounding residential areas which were likewise affected by the floods. The work of building the protection system, which will comprise dykes and sheet pile retaining walls, will commence this year.

As we have had to plan on the basis of existing floor space, we have – as reported in this injection – also

integrated our factories at St. Valentin and Steyr into the new production infrastructure. This concentration of technological competence is entirely in line with our strategical aim of making Engel even more flexible and efficient than hitherto. Consequently, in addition to the investments made at Schwertberg, we are also extending

our factory at St. Valentin. An additional production floor area of 6,600 m<sup>2</sup> will be going into service by July of this year. In a second phase, the production floor area of our factory at Steyr, which is now our competence centre for material technology and plasticizing units, will be more than doubled: from 2,200 m<sup>2</sup> to 4,700 m<sup>2</sup>.

All these changes will enable us to continue to serve you as your reliable suppliers and partners in the injection moulding field. Even the flood disaster could not deter us – you may rest assured that your "Engel family" will never let you down.

Yours

*Otto Urbanek*  
Otto Urbanek  
General Manager Technology



The warehouse for incoming goods (left) was heavily damaged by the floods and had to be rebuilt. Following the restructuring measures, the new building (right) will in future house the modern sheet metal working line and the downstream powder-coating installation.

## Engel Schwertberg after the floods: Everything back to normal



Necessity is the mother of invention (left): for six whole months, the training centre was the nerve centre of communications at Schwertberg. Right: 26.9.2002 – the first machines are ready for delivery, reason enough to celebrate.

**35,000 m<sup>2</sup> of industrial premises flooded six feet deep – any firm that has been hit, like Engel, by such a disaster is naturally faced with the difficult choice between two options: close down or continue? Never once considering the first option, Engel sees its "fresh start" as an opportunity to do everything better than ever before.**

>> Schwertberg, 13th January 2003: Anyone visiting Engel Schwertberg on this cold January morning cannot fail to notice all the hustle and bustle. Building contractors and craftsmen of every trade come and go in a continuous stream through the permanently open factory gate. The last of the new window panes are just being fitted on the ground floor of the office building, replacing the planks and plastic sheeting that had been giving makeshift protection against the wind, rain and cold for the past few months. A joiner is just installing a new reception desk in the entrance area, while, to the left and right of him, interior repairs and renovations are in full swing, as the noise of drills, tackers and hammers unmistakably indicates.

If one didn't know better, one might think that Engel was simply carrying out "normal" rebuilding measures, for even the informed vis-

itor can hardly tell that only five months ago – almost to the day – everything had been under six feet of water and uprooted trees had swept through the factory buildings, wreaking untold destruction everywhere. Apart from the "usual" inconvenience one associates with rebuilding and repair work, everything is in its place, as though nothing had happened, and everybody is back at work in their respective departments. Even the apprentices are hard at it, for Monday is theory day, too dull, perhaps, for those who prefer such practical though daunting exercises as "filing to size".

In short, everything is back to normal – or almost. What is still lacking for complete normality becomes clear when one takes a look at the far end of the production building. This used to be the frame and sheet metal shop for the small and medium-sized tiebarless machines. The interior of the building is still



Much more space for modernizing: the machine assembly shop has benefited considerably from the restructuring programme. – The still visible dividing line between "new" and "old" will soon disappear: Engel Schwertberg will then be scarcely distinguishable from a completely new production facility.



Our apprentices are already enjoying their up-to-date training shop. Bright and cheerful surroundings are much more conducive to learning how to put theory into practice.



Left: the completely rebuilt order preparation department of the central replacement parts warehouse has been fully operative since November 2002. Right: the rebuilding and renovation of the production facility was completed only four months after the flood; the first new production cells have already been put into service.

## – or almost!

being renovated. The presence of several new production machines immediately makes us sense that "something new" is in the offing.

### Consolidated production – greater flexibility

Two completely new production lines are being built. The "frame line" will in future produce machine parts which will then pass through a downstream structural unit assembly section and from there to final assembly. The second line, which will supply parts to the parts assembly section, is a highly automated sheet metal working line equipped with a new downstream powder-coating installation.

The new production lines are tailored to the modular concept which we developed with the introduction of the ENGEL VICTORY line. These new production lines will also enable us to consolidate our production processes, which in turn will bring about a reduction in downtimes and hence an increase in productivity. They will also permit us to integrate customers' special requirements into the production process much more flexibly than hitherto.

If everything goes according to plan, the main part of the new production facility will begin operation by the end of Engel's financial year (March 2003). The new and more efficient production machines will necessitate less floor area than has been needed so far, thus leaving more room for the planned enlargement of the assembly shop.

A completely new, state-of-the-art machine production facility, an enlarged assembly shop and more than double the floor space for application engineering (see page 1 of this issue of injection) – these are the visible, concrete results of Engel's recovery efforts after the floods. Although it would have been much easier to rebuild and optimize the production facility out in the open country – like Engel's facilities at St. Valentin and Dietach - the comprehensive restructuring programme coupled with investments in new buildings and machinery has in fact enabled us to open up the compact, "organically grown" structure of our parent factory at Schwertberg sufficiently for future development. This has in fact always been Engel's declared aim, and short, medium and long term investment had already been planned for further expansion at Schwertberg.

### Emergencies mobilize forces that reach beyond immediate needs

Naturally, it would not have been possible to overcome the emergency so quickly without the untiring efforts of our employees.

The mud and the debris have been cleared away, the main power supply network and the communication facilities have been restored, and Engel's central warehouse, paint shop, pre-assembly and final assembly shops have been back in operation since mid-September. The supply of parts from Engel's facilities at St. Valentin and Dietach, and also from out-

side suppliers, was soon organized. As many as 35 machines were completed and delivered as early as the beginning of October.

When the floods inundated Engel's Schwertberg factory, there were 130 machines in the assembly bays in various stages of completion. These machines have all been rebuilt. All parts susceptible to water – the hydraulics, electrics and electronics were fully replaced so as to ensure the same high standard of quality that Engel customers have always been accustomed to receiving. To this end, a team of engineers, assembly personnel and quality assurance experts supervised the rebuilding of every single machine, testing each one thoroughly prior to delivery.

At present we are still outsourcing many machine components. In order to guarantee optimum quality throughout, we have not just committed our new suppliers to delivering these parts "as specified" but have trained them "on the spot" as "qualified Engel suppliers".

The need for close collaboration and teamwork outside the normal scope of our responsibilities has forged even stronger bonds between us. Every single Engel employee has not only done his or her utmost to help in this time of crisis, but has also gained an understanding of the process as a whole, reaching far beyond the limits of his or her own function within the company. It is precisely this understanding which has stood us in good stead for the restructuring of our Schwertberg factory. Meanwhile, the steps taken by Engel Schwertberg towards its "new future" are manifesting themselves with ever increasing clarity.

This brief account of Engel's successful recovery from its biggest ever crisis would not be complete without mention of the fact that Engel has retained every single one of its employees. <<

>> Schwertberg, 19th September 2002, 15:22

Memo to all Engel employees.

We are delighted to inform you that, thanks to everyone's untiring efforts, we have now delivered and commissioned the first machine to be rebuilt after the flood disaster. Initial trials are at this moment being carried out on the machine with the first rebuilt mould. ...

This memo from the management announcing Engel's first delivery after the flood refers to a machine for the Austrian firm of Trodat, Wels, the world's leading manufacturer of rubber stamp and marking systems. The machine, a two-component injection moulding machine with four differently sized two-component moulds, had been ordered for the production of an innovative product line which Trodat intended to launch as a mass-produced article at the next trade fair. The machine had already been manufactured and was awaiting trials with the first mould which was nearly finished – but then came the floods and Trodat gave up all hope of realizing its project.

But not Engel. We never let our customers down if we can help it. – The Trodat machine was the first one to be transferred to St. Valentin for dismantling, cleaning and rebuilding. Our mould designers set up a temporary "design office" in St. Valentin and reconstructed the design drawings from back-up copies which – miraculously – had been saved. Although the moulds had to be outsourced from other mould making firms, our own mould making personnel could help out, for Engel had received permission – quickly and without any red tape – for its own personnel to be subcontracted to third parties. But there was one important point which still had to be considered. The project was "top secret", so we "chopped" the job into small pieces "beyond all recognition" and shared it among 18 mould makers in all parts of Austria!

In spite of the fact that there was no hope whatsoever of working at Schwertberg, for the clearing work was far from finished, we succeeded in completing and delivering the machine and the moulds only a week later than originally planned.

>> Trodat did of course manufacture its new product line in time for the trade fair, where its launch was an unqualified success. <<



Schwertberg in August 2002: in next to no time, the waters of a normally harmless little river – the Aist – had risen by between 4 to 5 metres. Huge torrents of water inundated a good half of Schwertberg (Engel's factory is just visible below the top edge of the photo). Planned flood protection measures will guard Schwertberg against such disasters in future.



Just one example of the devastation caused by the flood in the office building: water and mud completely destroyed the infrastructure, especially the underfloor EDP network (left); repair and restoration work began with the removal of the old composition flooring. – Right: Things have been back to normal in the purchasing department since the middle of February.





MCP's injection moulding shop: the tiebarless machines (in the foreground) are used primarily for the production of small and medium-sized dashboard components, including IMD parts.



Production cell with one of the two 3,200 tonne DUOs and an ERG 303/1-N demoulding robot for the production of large parts.



## Well on its way to being a world-class supplier

Established in Tehran in 1993 as a design and engineering office for vehicle parts and moulds, Mehr Cam Pars is meanwhile the largest automotive system supplier in Iran. MCP's corporate philosophy also expresses its objective: "We will be one of the best and excellent world class automotive suppliers by the year 2005." Injection moulding technology and know-how from Engel will go a long way towards helping MCP to achieve this corporate target.

>> Mehr Cam Pars Co. (MCP) was founded as a private joint stock company in 1993 on the initiative of the Iran Khodro Group, Iran's largest manufacturer of passenger cars and commercial vehicles. Equipped with modern CAD workplaces, MCP started as a design and engineering office in Iran's automotive industry complex in Karaj, a suburb of Tehran. As a party to the co-operation agreement between Peugeot and Iran Khodro, MCP's main task for the first three years consisted both in adapting automotive components and sub-assemblies to local conditions and requirements and in the design and development of moulds. In 1995, after the Iranian government had passed measures for strengthening Iran's

domestic automotive industry, MCP seized the opportunity to branch out as a supplier of automotive parts itself. The first assembly shop was soon built and MCP then began to assemble dashboards and bumper systems for Iran Khodro. The necessary plastic components came from outside suppliers. A second, much larger assembly shop was built in 1996/97. Around the same time, MCP signed a licensing agreement with Valeo for the manufacture of car ventilating and air-conditioning systems.

All these activities were aimed at acquiring, as quickly as possible, the necessary expertise and capacity for the local production of system components in compliance with international standards.

with a linear robot (ENGEL ERC 303/1-N) and peripherals. The injection moulds came from France

The second stage was completed mid-2002, when a machine package comprising three tiebarless ENGEL VICTORIES (800, 1,750 and 2,500 kN clamping force, all equipped with ENGEL ERC linear robots) was integrated into MCP's production. These machines are used for the production of in-mould decorated inserts and panels for dashboard systems. A further two large DUO machines (17,000 and 20,000 kN clamping force), both equipped with ERC robots, followed in November 2002. Both machines manufacture various interior trim parts (e.g. A, B and C pillar trim). These seven fully automated Engel machines form the nucleus of Mehr Cam Pars' production facility for high-quality injection moulded parts.

### Achievement through partnership

In order to meet the requirements of car manufacturers, MCP had to reach the internationally applicable quality and production standards as quickly as possible. MCP decided that its best strategy was to "purchase" its much needed know-how. A thorough market analysis showed Engel to be the ideal partner for the injection moulding project, not least on

### Courageous start in state-of-the-art plastics processing

MCP's choice of supplier for the injection moulding machines which were now needed was based not only on machine quality but also on the service capabilities of the supplier. Engel won the contract because it was able to offer the whole package: a wide range of machines from small to large, its own series of matching robots and automation systems and its many years' experience and expertise both in mould design and in plastics processing technology. Added to this was the fact that Engel had now been selling machines to Iran for a good 30 years and had excellent references there.

As it was precisely the supply of large parts – such as bumpers and dashboards – which had top priority with Iran Khodro, MCP had no alternative but to gain its initial injection moulding experience on large-capacity machines – a courageous step indeed. The first machines were two ENGEL DUOs, each with a clamping force of 32,000 kN and equipped



Shown here is one of the tiebarless Engel machines, equipped for the IMD process, producing the in-mould-decorated Samand emblem which is integrated into the radiator grille.



MCP has a large part to play in the manufacture of Iran's new "national automobile", the Samand. One example is this module with dashboard and centre console, delivered on a just-in-time basis to Iran Khodro's assembly line.

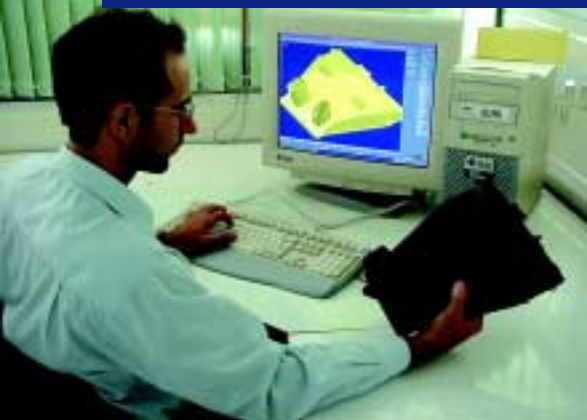
### A mirror of Iran's automotive industry: Iran Khodro and MCP

Mehr Cam Pars features strongly in the relatively young history of Iran's automotive industry, which began when Iran Khodro was founded in 1962. Instead of importing vehicles, Iran Khodro built them itself from imported parts. Mercedes buses and British Leyland cars (the legendary Hillman Hunter – the "Paykan" in Iran – is still being built today) were the first to come off the assembly line. During the next thirty years, the proportion of locally produced parts gradually increased. New joint projects in the 1990s, especially with Peugeot in the car sector, heralded the modern era of Iran's automotive industry. Iran's first "national automobile", the Samand, has been on the road since 2002. Today, Iran Khodro is the largest of the three car manufacturers in Iran. The Iran Khodro Group is engaged in every area

of vehicle production, from design and development through component manufacture to the final assembly of cars, vans, buses, station wagons and light trucks. ([www.ikco.com](http://www.ikco.com))

MCP began business in 1993, initially using the design and engineering know-how of Iran Khodro, though very soon progressing to become a competent manufacturer of vehicle parts and systems in its own right, thanks not least to western engineering and management know-how. Offering an all-in package, from initial development through to the finished, ready-to-install part, MCP produces complete dashboards and centre consoles, interior door modules and complete front and rear bumper modules. MCP also manufactures car ventilating and air-conditioning systems under licence from Valeo. Much of MCP's production is for Iran Khodro (cars) and Iran Khodro Diesel (commercial vehicles). The bumper systems are built primarily for Peugeot/Iran. Peugeot replacement parts are even exported world-wide. The company currently employs around 900 people. Sales in 2002 were in the region of US \$ 73 million. ([www.mehrcampars.com](http://www.mehrcampars.com))





Automotive system supplier MCP: from the initial idea and its CAD realization (top photo) to the ready-to-install module, such as this front end for the Peugeot 405 Pars (bottom photo), paint-finished to match the colour of the car.



## Engel's "new" mould making department: State-of-the-art engineering at your service

Engel's "new" mould making department is just one example of how the Engel Phoenix Project has already become a reality: as one of the technology pillars, this department has now been strengthened with new machines and equipment and will continue to be one of the main driving forces behind Engel's growing competence in the field of Combimelt injection moulding technology.

account of Engel's large share of the market for large-capacity machines and its experience as a longstanding supplier to the automotive industry. Further decisive factors, in addition to the machine technology offered, were Engel's competency in solving processing problems, its world-wide service network and its vast experience with such projects.

When Engel joined the project, the outer walls and roof of the injection moulding shop had already been built, but its interior was still a building site. Thus the first step taken jointly by MCP and Engel was to plan the entire infrastructure of the production facility – from the machine foundations through to the energy supply system. The success of this project was due not least to the training of the machine operators and to the on-the-spot assistance given during the first few months of operation.

A factor equally important for the success of the project was the integration of non-Engel system components and peripherals into the injection moulding cells. A typical example was the integration of the system for the production of IMD parts. MCP had here decided in favour of the IMD systems manufactured by Leonhard Kurz GmbH & Co. KG, Fürth/Germany. The high quality of the IMD parts is dependent on an optimum flow of melt in the mould cavity, and this in turn is dependent both on the design of the gates in the mould and on the accuracy of the process control system.

### MCP today: a leading automotive system supplier

In less than five years, the management team succeeded in transforming Mehr Cam Pars from a design and engineering office into a full-service automotive system supplier. The company offers products ranging from pre-production parts through to ready-to-install structural units. In plastics processing, MCP is an expert not only in injection moulding but also in extrusion, foam moulding, thermoforming, welding and surface coating – fully equipped with state-of-the-art machines for these processes. The fact that MCP can already match up to "western standards" is evidenced not least by its compliance with such international quality standards as ISO 9001 and QS-9000. Successful co-operation with international car manufacturers underlines the success of the strategy implemented by MCP. <<

>> Whenever the need to combine functions and properties calls for the development of an innovative plastic product, Engel's mould making department is always involved right from the very start. Engel's mould making specialists have already gained a significant lead in a special technology for the efficient production of high-precision composite injection moulded parts: Engel "Combimelt". Its application spectrum ranges from rigid/flexible composites, such as industrial components with integrated seals, to composite parts moulded from engineering plastics featuring different properties and/or different colours.

### New technology for new possible applications

Completely re-equipped after the flood disaster, the mould making department now works with machine tools featuring the very latest technology. Special priority has been given to 3D machining. The use of the most advanced high-speed milling machines and spark erosion technology in conjunction with 3D design and measurement technology opens up completely new possibilities for the free-shaping of mould cavities.

Given the necessary software, the measurements of free-formed surfaces can be taken directly from a three-dimensional model. Without any geometrical limitations whatsoever, every single point on the surface of the analog model can be determined for the purpose of generating a virtual, digitized model. The process can of course take place in the reverse direction, too: the stored data of the model are the reference data for the quality control of machined parts and of the complete mould.

### 3D and paperless – from start to finish

The starting point of every mould design project is the customer's concept. Engel's application engineering experts are called in at this initial stage to help examine the customer's design model from the production aspect: position of the parting lines, gate location, necessary draft and a dozen other things must be discussed. Once all questions have been clarified, a 3D digital model is generated as the basis for the 3D design of the injection mould. All necessary parts for the construction of the mould are now available as "solids" for the CAM department.



Three-dimensional and networked from start to finish: from the exact measurement and digitization of the model in the measuring room (top photo) through the design of the mould and the interaction of its individual component parts (middle photo) to the accurate alignment and centring of the workpieces (bottom photo) in readiness for machining on the CNC machines which are likewise integrated into the network.

erated as the basis for the 3D design of the injection mould. All necessary parts for the construction of the mould are now available as "solids" for the CAM department.

The CAM department (CAM = Computer Aided Manufacturing) uses these "solids" to generate the programs required for the production of the mould, e.g. the electrodes necessary for the spark erosion process, the milling programs and the grinding programs. For the last-mentioned process, Engel is equipped not only for cylindrical grinding but also for the polygonal grinding of up to 72 surfaces.

All data are prepared centrally on a server. The machining centres access these data via a network and update them with their own results as their work progresses. Each individual part is given a job number, enabling its process of manufacture to be traced all the way through to its combination with the other parts of the mould, its final measurement and its release with a test certificate – a basic prerequisite for the reliable supply of replacement parts and subsequent maintenance.

### Process-optimized high-tech moulds

With its highly efficient, state-of-the-art machines and equipment and its fully integrated CAD/CAM production system, Engel's mould making department designs and constructs high-tech injection moulds which give not only years of service but also the highest degree of precision and the highest level of performance: all moulds from Engel are process-optimized, thanks not least to the fact that Engel combines and co-ordinates all its know-how and expertise under one roof. Thus the mould making department always works in close collaboration with the departments responsible for machine design and construction, applications engineering and robotic systems and peripherals for automated mass production.

>> Injection moulding technology as a complete package from one single supplier – this is the very essence of Engel's philosophy. The customer does not take delivery of "just" a mould. He receives much more: Engel state-of-the-art engineering for the most demanding mass production requirements. <<

## Three LSR layers in one operation – without any need for subsequent finishing

The firm of ABB Energiekabel operates world-wide in the design and manufacture of medium and high voltage cable systems up to 550,000 volts. An ENGEL ELAST three-component LSR injection moulding machine has now been put into service for the automated mass production of a medium voltage cable terminator.



Examples of the ready-to-fit medium voltage cable terminators manufactured by ABB Energiekabel (Photo: ABB Energiekabel GmbH).

>> ABB Energiekabel GmbH, Mannheim, belongs to the ABB Group. ABB is the world's leader in the field of energy supply and automation technology. This Mannheim cable company specializes in particularly high system voltage (up to 550 kV) and medium voltage cables (6 to 45 kV) and the necessary cable fittings. Such fittings serve to connect cables together and to connect their ends to other electrical equipment such as transformers and switchgear. They are as important for the reliable operation of cable systems as the cables themselves. ABB Energiekabel, which is renowned for its innovative products, offers a

range of cable fittings which are optimally adapted to all cable system requirements: from outdoor and indoor cable terminators and plug-type terminators for the connection of cables to totally enclosed, gas-insulated switchgear through to cable assemblies and a whole diversity of accessories, such as tools for cable system assembly.

### Discharged from the machine fully finished

The cable fitting now being mass-produced fully automatically by ABB Energiekabel is a medium-voltage T-type cable terminator. It is moulded entirely from HTV silicone (HTV = high temperature vulcanizing). Silicone is particularly suitable for this application because it is not just extremely durable but displays very good electrical insulating properties and can also – where needed – be rendered electrically conductive.

The cable termination is, by reason of its function, built up in three layers. It has a conductive core which is separated from the conductive outer layer by an insulating layer of silicone. These three layers are injection moulded in LSR (liquid silicone rubber) in three steps. All three steps are executed simultaneously in the three-cavity mould in one injection cycle. The inner conductive layer is moulded around a T-shaped metal core in the first cavity, the insulating layer is added in the second cavity and the conductive outer layer, which also gives the product its ultimate shape, is moulded in the third cavity. When the mould opens, the robot removes all three parts, places the completely finished part in the pre-heating station (workpiece fixture outside the machine), re-arranges the two unfinished parts in readiness for re-positioning in the mould, picks up

the new core from its waiting position in the pre-heating station and then places all three parts into the mould cavities.

As the mould closes for the next cycle, the robot returns to the pre-heating station and picks up the finished cable terminator and transfers it to another station where the core is removed – fully automatically – with the aid of compressed air. The finished part is then laid on the discharge conveyor belt, while the metal core is reassembled into its "T" shape and returned to its waiting position in the pre-heating station in readiness for the next injection cycle.

The injection moulding machine has been tailored exactly to the application. The nucleus of the machine is an ENGEL ELAST 250 V, an LSR injection moulding machine with a clamping force of 2,500 kN and a central, fully hydraulic clamping cylinder. Two additional high-speed cylinders ensure rapid opening and closing of the mould. The tiebars of the clamping unit have been made 200 mm longer than standard in order to accommodate deep moulds.

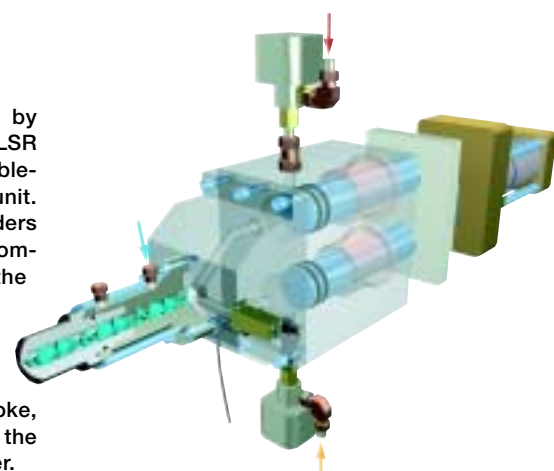
Three LIM (liquid injection moulding) double-plunger injection units, arranged horizontally on three sides of the clamping unit, meter the LSR into the three cavities with extreme accuracy. Featuring swept volumes of 6,000 cm<sup>3</sup>, 3,000 cm<sup>3</sup> and 1,000 cm<sup>3</sup> respectively, all three units are capable of generating an injection pressure of up to 500 bar.

Now that this first fully automatic production machine – ABB Energiekabel's production hitherto had involved a great many manual finishing operations – has fully proved its capabilities, a second ENGEL ELAST 6000H/3000H/1000H250V-3F EL LIM will soon be mass-producing similar parts – and likewise without any manual intervention. <<



The articulated-arm robot with transfer head in waiting position before the closed mould (left photo) and the three demoulded parts (middle photo): the second stage (front, coloured red), the finished part (immediately behind it) and the first stage (extreme rear). Right photo: The finished medium voltage cable terminator as it comes from the machine. The black LSR layer is conductive, the red LSR layer is non-conductive.

Specially developed by Engel for large-volume LSR moulded parts: the double-plunger injection unit. Once the two cylinders have been filled with components A and B – in the given mixing ratio, which can be varied as required – the pistons, which are driven by a common yoke, force the material into the mould via a static mixer.



## injection

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## News in brief News in brief News in brief News in brief News in brief News in brief News in brief News in brief

>> Engel's youngest generation of injection moulding machines has now been extended:  
>> The new E-MOTION 180 (1,800 kN clamping force) now increases the performance range of the ENGEL E-MOTION series of all-electric, tiebarless injection moulding machines.  
Available as standard with this new machine, which is so far the largest of Engel's all-electric machines, are two injection units (international type-size designations 440 and 740) each featuring two screw diameters (35/40 mm and 45/50 mm respectively). The new machine thus meets the needs of those customers who also wish to benefit from this series' extremely high precision and repeatability in a higher range of clamping forces than those covered by the machines hitherto available.

### New addition to E-MOTION Series



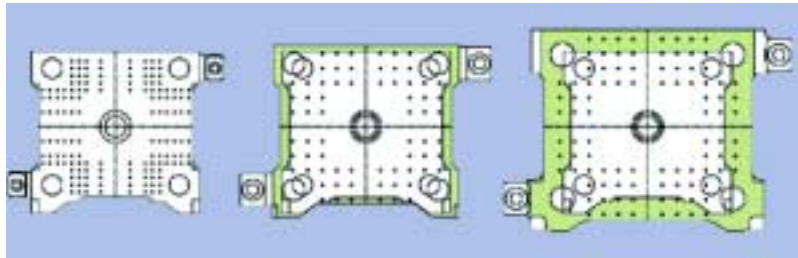
With the addition of the new ENGEL E-MOTION 180, Engel's series of all-electric, tiebarless injection moulding machines now covers the range of clamping forces from 550 to 1,800 kN (in individual machine sizes 550, 1,000, 1,000 and 1,800 kN).

### Just as strong in Europe

Ever since the current series was launched at the beginning of 2001, Engel has been successfully selling its all-electric machines not only on the North American continent – market surveys had predicted that North America would be their main market – but in Europe, too. Even the Swiss now owe their proverbial precision to many an ENGEL E-MOTION machine.  
Engel all-electric injection moulding machines are generally used in cases where hydraulic machines have reached the limits of their performance in terms of precision and repeatability, i.e. when producing high-precision industrial components with small to medium shot weights. <<

## ... ENGEL DUO WP/WPX?

These new DUO options offer the benefit of greater flexibility when configuring a machine with standard modular units: with the versions DUO WP (wide platen) and DUO WPX (extra wide platen), Engel's two-platen injection moulding machines are now available with larger platens, in addition to the existing standard platens, in each machine size category.



Like the tiebarless ENGEL VICTORY machines, the ENGEL DUO machines now offer the user a choice of three platen sizes in each machine size category: the existing standard platen (left), the wide platen of the DUO WP version (middle), or the extra wide platen of the DUO WPX version (right).

>> For some applications, it is not the required clamping force which decides the size of the machine but the necessary platen dimensions for the size of mould to be used. Multi-cavity moulds, moulds for in-mould decoration with films and fabrics or moulds for injection-compression moulding are just a few examples of such cases of application. The modular system featured by the tiebarless ENGEL VICTORY, for example, offers the user the best possible combination of clamping force and platen size. The three standard platen sizes give him sufficient flexibility for optimum utilization of the machine's rated clamping force.

In modularizing its series of large-capacity ENGEL DUO two-platen machines, Engel has likewise increased their flexibility of application by equipping them with a choice of platen sizes. In the machine range up to 1,100 tonnes clamping force, the user can now choose between the DUO Standard, the DUO WP (wide platen) and the DUO WPX (extra wide platen).

The 1,500 tonne DUO is available with either a standard or a WP platen. The following comparison

exemplifies the differences between Standard, WP and WPX.

### 7700 tonne DUO WPX: more mould space than on a 1,100 tonne DUO Standard

A DUO Standard can be converted to a WP or WPX version by equipping it with a machine frame, platens and high-speed cylinder belonging to the next or next-but-one larger size of machine module from the DUO range, whilst the tiebars and the pressure pads for the application of the clamping force remain standard in all three specifications (see table). Accordingly, the 700 tonne DUO WPX features, on account of its thinner tiebars, larger mould mounting dimensions between the tiebars than are featured on the 1,100 tonne DUO Standard (the same goes for the 700 tonne DUO WP in comparison with the 900 tonne DUO Standard).

>> ENGEL DUO Standard, WP, WPX – the new modular system standard for injection moulding with even greater efficiency. <<

Clamping force < kN > Equipment	Distance between tiebars < mm x mm >		
	DUO Standard	DUO WP	DUO WPX
<b>7,000</b> Platens + HS cylinders Tiebars + pressure pads	<b>1,025 x 930</b> DUO 700 DUO 700	<b>1,190 x 1,020</b> DUO 900 DUO 700	<b>1,440 x 1,190</b> DUO 1100 DUO 700
<b>9,000</b> Platens + HS cylinders Tiebars + pressure pads	<b>1,170 x 1,000</b> DUO 900 DUO 900	<b>1,420 x 1,170</b> DUO 1100 DUO 900	<b>1,595 x 1,340</b> DUO 1500 DUO 900
<b>11,000</b> Platens + HS cylinders Tiebars + pressure pads	<b>1,400 x 1,150</b> DUO 1100 DUO 1100	<b>1,575 x 1,320</b> DUO 1500 DUO 1100	<b>1,860 x 1,460</b> DUO 1700 DUO 1100
<b>15,000</b> Platens + HS cylinders Tiebars + pressure pads	<b>1,530 x 1,275</b> DUO 1500 DUO 1500	<b>1,815 x 1,415</b> DUO 900 DUO 1500	–
<b>17,000</b> Platens + HS cylinders Tiebars + pressure pads	<b>1,805 x 1,405</b> DUO 1700 DUO 1700	–	–

Platens for the DUO modular system: With the DUO 700, 900 and 1100, the user can choose between the standard, the wide WP and the extra wide WPX platen. The DUO 1500 can be equipped with a standard or a wide platen. The DUO 1700 machine (and larger) is available with standard platens only.

## The new R9 non-return valve

Launched in 1996, Engel's marathon non-return valve has meanwhile proved itself a good 20,000 times in practice. This first generation (R8) of special carbide coated, hard-wearing, corrosion-resistant non-return valves has for the past year or so been succeeded by the new R9 version. Its optimized geometry gives a considerably improved, much more constant closing action.

>> The non-return valve serves the purpose of preventing the accumulated reservoir of melt from flowing back into the screw channel during the injection phase. This is done – in the case of the most commonly used types of non-return valve – by means of a freely rotatable and displaceable check ring which presses against a stop ring as the pressure builds up in the space in front of the screw. During the metering operation, this check ring is forced forwards against the flights of the screw tip, enabling the melt to flow freely into the space in front of the screw. The non-return valve must be able to perform this operation with precise reproducibility from one shot to the next so as to ensure the necessary conditions for the production of a uniformly high quality of moulded part.

stroke, the more negligible were the fluctuations in the melt cushion. The third largest influence was the flight width at the screw tip – the narrower the flights, the better the closing action. And the same went for the check ring, too – the thinner the ring, the better it closed. It was also found that there was an optimum cross-sectional area for the melt flow-way, the determining factors being the material and the mould geometry.

These findings have all gone into the design and making of the new R9 marathon non-return valve. Its improved geometry offers an optimum state-of-the-art combination of service life (guaranteed at least one year) and reproducible closing action (see shot weight graph).



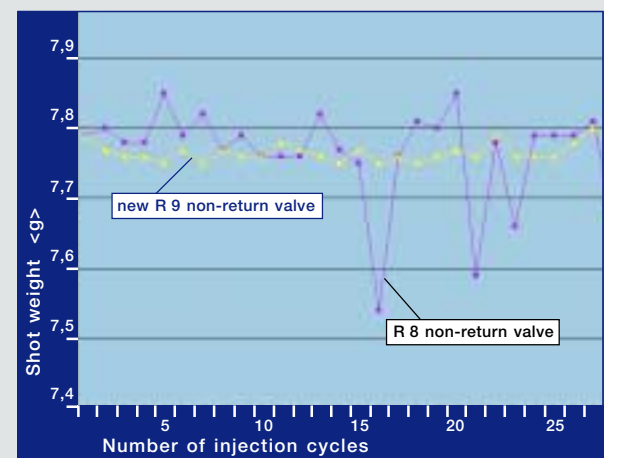
A tiebarless 200 tonne injection moulding machine, fully equipped for every required measurement, was used for the systematic testing of the non-return valves.

But does the ring-type non-return valve actually operate with such a high degree of reproducibility? What geometrical parameters exercise an influence on its closing action, and to what extent? These and other questions had to be tackled by Engel's development engineers when the marathon non-return valve came up for revision.

### Putting geometry on the test bed

A large permutation of geometrical parameters was examined in practical tests: length and thickness of the check ring, the clearance between the check ring and the cylinder, the flight width at the screw tip and even the cross-sectional area of the melt flow-way. The measuring equipment of the "laboratory machine" monitored the melt pressure profile immediately upstream of the non-return valve, indicating whether and when the valve closed. The valve is still open at the beginning of the injection phase (pressure build-up), which means that pressure also builds up behind the non-return valve. As soon as the valve closes, this upstream pressure drops to zero. Thus the peak of the curve of the pressure-time graph indicates precisely the point in time at which the valve closes.

Most importantly, the results showed that the clearance between the check ring and the cylinder considerably influenced the closing action of the non-return valve – the greater the clearance, the greater the shot-to-shot fluctuations in the melt cushion. The second largest influence was the stroke between the open and shut position of the check ring – the shorter the

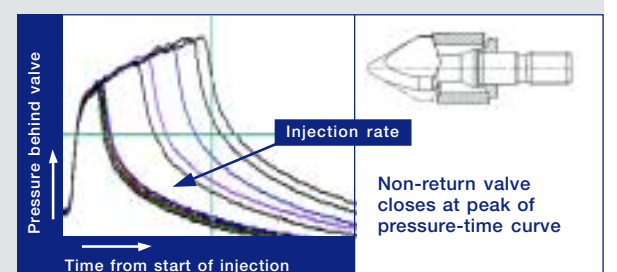


Influence of non-return valve geometry (existing R8 and new R9) on shot-weight reproducibility when processing polystyrene (PS at an injection rate of 30 mm/s).

### Process parameters also decide

As every processor knows, the shot weight need not necessarily always be constant even though the same non-return valve may have been used. Indeed, practical application shows that the closing action of a non-return valve is influenced not just by its geometry but also by the material, the actual process parameters (see graph below), mould resistance and screw geometry. But even in this respect an optimally functioning non-return valve, such as the R9, permits better control of such influences than is possible with a geometrically "unstable" valve.

Should a ring-type non-return valve fail to give the desired result (e.g. when processing free-flowing, unreinforced polymers), the processor can always fall back on the Engel cone-type non-return valve, which works independently of pressure and temperature control. <<



As the injection rate increases, the non-return valve closes not only faster as a matter of course, but also while the pressure behind the valve is still relatively low. Through the improved closing action of the valve, less material flows back into the screw channel.

## New sales and service branch: Engel Finland Oy

>> Since 1st November 2002, Engel Finland Oy has been operating as an independent sales and service branch for Engel injection moulding machines. The decision to establish this branch was taken in mutual agreement with Oy Ekström AB, Espoo, which has been Engel's Finnish agent ever since this Austrian firm entered the Finnish market back in 1965 and has meanwhile developed its business in Engel machines to the significant reputation which it enjoys today.

All of the Ekström employees hitherto engaged in the sale and servicing of Engel machines will be taken over by Engel Finland Oy, thus ensuring optimum continuity of service to Engel/Ekström customers. Moreover, Engel Finland Oy, being a branch establishment of Engel, now has direct and even readier access to the Austrian parent company's know-how pool and service facilities. The in-

clusion, for example, of this new branch in Engel's replacement parts network will further increase the efficiency of Engel's CSD system, while the integration of the local organization in Engel's global information system and its adoption of Engel's Corporate Identity will help to facilitate – and hence improve – working with globally operating companies in Finland and/or with Finnish companies that have branches and subsidiaries abroad. This is the experience already made by Engel in Sweden, where Engel's sales agency Karlebo Plast AB was converted into the Engel branch Engel Sverige AB in 1991. Engel Finland Oy is for the time being operating from offices in Helsinki, but plans are already being made for a new building in the Greater Helsinki area. However, the existing decentralized service organization, with its three local service offices, will remain in operation. <<



The sales and service team of Engel Finland Oy (from left): Anders Nybäck (General Manager – Sales), Jukka Miinalainen (Service Engineer), Che Mätzke (Service), Timo Peltomaa (Service), Ville Koskinen (Service), Helena Palaskari (Administration), Juha Kotilehto (Service), Maria Engblom (Sales), Christian Feth (Replacement Parts Manager), Seija Holstila (Administration) and Ralf Nikander (Sales – for many years manager of the Engel department of Oy Ekstroem AB).

## Wanted ...

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Informants please contact: Reinhard Bauer  
Tel.: +43/7262/620-3060, Fax: -1 3060; E-Mail: reinhard.bauer@engel.at  
Reward: A report in the next issue of injection.

>> Since 1989, Engel has manufactured and delivered more than 17,000 tiebarless injection moulding machines. These machines afford a wide scope for innovative applications. Unrestricted access to the clamping unit, total freedom of robot movement, linear bearings for the effective support of heavy moulds – these are the key features behind the creativity potential of the system, the intelligent exploitation of which will again be honoured by the "ENGEL HL AWARD" (HL means "tiebarless") and presented in a suitable form at the award ceremony.



In keeping with tradition, the award ceremony always takes place during one of the big events of the year. The chosen event this year is the "Engel Symposium 2003", which will be taking place in Schwertberg and Linz from 13th to 15th May 2003 (for details see Engel's website [www.engel.info](http://www.engel.info)).

The ENGEL HL AWARD in gold, silver and bronze will be presented during the evening function on 12th May 2003 in the Brucknerhaus in Linz. Short films of the three winning projects will be shown. <<

## Engel sales agency in Brazil moves into new premises

>> Since 1991, Engel has been steadily expanding its business in Brazil through its sales agency "HDB Representações" in Sao Paulo. Over 700 Engel machines have meanwhile been sold to customers in Brazil, most of them being large-capacity ENGEL DUO machines for the local automotive industry and a

relatively large number of tiebarless machines for the production of fittings and automotive components.

In order to be able to match its service to the position which Engel meanwhile holds in the market, Engel's Brazilian agent, Herbert Buschle, has had new premises built for his 25-strong team in Sao Paulo. Inaugurated in August 2002, the new premises have 1,100 m<sup>2</sup> of office space, a large exhibition room for machines up to 4,000 kN clamping force and a modern training room for up to 20 people.

Besides its main place of business in Sao Paulo, HDB has sales and service branches in Joinville, Porto Alegre and Salvador. <<



## Georg Schwarz celebrates his 75th birthday

>> Georg Schwarz, the long standing "senior" in Engel's management, celebrated his 75th birthday on 18th February 2003. Engel's present standing as a "Global Player First Class" in the injection moulding machine industry is ascribable not least to the entrepreneurial farsightedness, decisiveness and perseverance of Georg Schwarz.



Born in Esseg (Croatia) in 1928, Georg Schwarz moved with his parents to Austria in 1945. He took a three-year course in mechanical engineering at Linz Technical College and then served an apprenticeship as a fitter. In 1952, he obtained his master craftman's diploma in mechanical engineering. The practical experience gained through his work in the factory founded by his father-in-law, Ludwig Engel, was augmented by evening classes in commercial studies and management courses.

In 1951, Ludwig Engel appointed Georg Schwarz to the position of works manager. He was appointed sales manager in 1957. From then on he succeeded, step by step, in realizing his vision of Engel as an international

company. When Georg Schwarz and his wife Irene (née Engel) took over the management of Engel Maschinenbau Ges.m.b.H. after the death of Ludwig Engel in 1945, the company had a workforce of only 438. His vision of close customer relations and his undeterred belief in the potential of injection moulding in industry contributed decisively to the development of this medium-sized firm of the sixties into one of the world's leading manufac-

turers of injection moulding machines and systems. Georg Schwarz has remained an "engineer through and through" throughout his entire entrepreneurial career. He has always championed modern industrial building and state-of-the-art production methods – a guiding principle which still rules today.

At the end of 1997, Irene and Georg Schwarz handed over the management of the operative companies to a management team. Good entrepreneurs, however, are "bad" at going into retirement. And so it is that the Georg Schwarz and his wife are still very active members of the Supervisory Board – for the continued benefit of us all. <<

## New competence centre in Hagen, Germany

>> Engel's new "Competence Centre for Injection Moulding Machines and Automation Technology" in Hagen, Germany, has been in operation since January 2003. It accommodates both the sales and service branch hitherto based in Cologne and the new German company Engel Automatisierungstechnik Deutschland GmbH, which was formed on 18th April 2002. Built within only six months on an area of 8,000 m<sup>2</sup> with a usable floor space of 2,000 m<sup>2</sup>, the new building is equipped with offices, assembly sections for automation equipment, a showroom for machine demonstrations and customers' trials and a well-equipped training and seminar facility.



service. Components such as linear robots, tray servers and belt conveyors are supplied by ENGEL AUSTRIA in Dietach and, together with locally manufactured components, are combined to form complex automation systems for every imaginable application.

By integrating automation technology into the spectrum of products and services offered by its three sales and service branches, Engel Deutschland has created a new dimension in customer relations: assistance with problems is immediate, complex systems can be developed in the shortest conceivable time and Engel's automation specialists are still available "on the spot" after the system has been delivered and installed. <<

## Calendar Calendar Calendar Calendar Calendar Calendar

### Please visit us at ...

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| <ul style="list-style-type: none"> <li>■ <b>M-Plas 2003</b><br/>Kuala Lumpur, Malaysia<br/>10.04. – 13.04.2003</li> <li>■ <b>Chemexpo 2003</b><br/>Budapest, Hungary<br/>23.04. – 26.04.2003</li> <li>■ <b>Plast 2003</b><br/>Milan, Italy<br/>05.05. – 10.05.2003</li> </ul> | <ul style="list-style-type: none"> <li>■ <b>Engel Symposium 2003</b><br/>Linz and Schwertberg, Austria<br/>13.05. – 15.05.2003</li> <li>■ <b>Plastpol 2003</b><br/>Kielce, Poland<br/>27.05. – 30.05.2003</li> <li>■ <b>NPE 2003</b><br/>Chicago, USA<br/>23.06. – 27.06.2003</li> <li>■ <b>Chinaplas 2003</b><br/>Peking, China<br/>09.09. – 12.09.2003</li> </ul> | <ul style="list-style-type: none"> <li>■ <b>MSV 2003</b><br/>Brno, Czech Republic<br/>16.09. – 20.09.2003</li> <li>■ <b>Fakuma 2003</b><br/>Friedrichshafen, Germany<br/>14.10. – 18.10.2003</li> <li>■ <b>Plustex 2003</b><br/>Cairo, Egypt<br/>16.10. – 19.10.2003</li> <li>■ <b>EuroMold 2003</b><br/>Frankfurt am Main, Germany<br/>03.12. – 06.12.2002</li> </ul> |
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