

innovations

Techniques – Markets – Trends

Volume 12 – 3/2018

**WITTMANN
BATTENFELD**
*celebrates
its birthday!*



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Editorial

Content



**Georg
Tinschert**

Dear Reader,

What began ten years ago with the integration of BATTENFELD Kunststofftechnik into the WITTMANN Group has become an uninterrupted success story. Previously, both companies had already followed the principle of continuous improvement by innovation in processing technology. WITTMANN had experienced continuous growth over many years, while BATTENFELD was facing the possibility of having to disappear from the market due to corporate restructuring.

The takeover effected on 1 April 2008 – which led to the revival of BATTENFELD – now under the umbrella of the WITTMANN Group – could be compared to the rebirth of the phoenix from the ashes in terms of symbolism. Admittedly, this sounds rather melodramatic, but the events which led up to the takeover were certainly turbulent. It was due to the ever-present strategic decisions made in the background that such a successful project could emerge from this takeover.

The overriding strategy from the very beginning was to focus the strength of both companies on offering you special advantages from using our products and services. On the one hand, by the use of individual high-performance products as parts of a comprehensive product portfolio, on the other hand, through the additional benefit created by the high integration potential of all components. Moreover, in a family-owned business with a long-term perspective like ours, you can count on having a reliable partner for many years to come.

Under the brand name of *PowerSeries*, the last ten years have seen a revision of the entire range of machinery. The *PowerSeries* models stand for sturdiness, maximum productivity, outstanding energy efficiency and optimal user-friendliness. From the beginning – even before the *Industry 4.0* concept became a guiding theme – our goal of harmonizing the control systems of the machines, automation equipment and peripherals was a major concern, that is the endeavor to connect up all components virtually without interfaces. Today, all modules of an injection molding production cell can be integrated under the one roof of *WITTMANN 4.0*, which is an essential prerequisite to fulfill the requirements imposed on a SmartFactory according to the *Industry 4.0* principle.

Our facility in Kottlingbrunn, Lower Austria, is now presenting itself in a new outfit. Our great success has made it necessary to expand the production floor of the machine manufacturing plant once more. As a part of this most recent building project, the office building has also been extended together with optimizing the assembly processes. We are looking forward to welcoming you in Kottlingbrunn!

Yours cordially, Georg Tinschert

Injection Molding

Metal injection molding



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Swiss prime quality



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Mimest, Italy: the perfect synthesis

*Technology, labor, and an ongoing trend. –
The history of an Italian company that was able to get ahead
in the niche market of metal injection molding.*

Stefano Troilo

When matching the technology of injection molding of thermoplastic polymers on one hand, and the sintering of metal powders on the other, one gets to MIM technology (Metal Injection Molding). This is a process that optimizes the development of particularly complex objects with complicated shapes, including those that would be hard to realize through metal casting.

A view of the MIM production facility of Mimest in Trento, Italy.

The first MIM applications took place more than 35 years ago in the IT industry, and even though it cannot be considered as a new technology, it is not very commonly applied.

Today, the main volume happens in the UK, the Far East and in India, followed by Europe (as an accessory matter of the automotive industry).

Apart from the screw, the cylinder and a few other accessories, the injection molding machines are the same as used for the molding of plastic parts.

An all-Italian challenge

In 2005, four engineers that specialized in metallurgy, plastics engineering, mechanics, and design, decided to get together and share their skills and abilities to set up a company called Mimest in Trento (Italy). There were several reasons for this ambitious decision: “First of all, we wanted to put our skills into practice professionally. Then we wanted to approach a technology that was still not completely explored,” explains Matteo Perina, the Managing Director.

The years went by and the company, led by Matteo Perina and Rudj Bardini, the Technical Director, grew bigger, becoming stronger and stronger in the special field of MIM technology. “Growing was a slow and gradual process,” Perina adds. “In the beginning, we invested in knowledge about the production process, and also in the development work of special machinery for the optimization of powder mixing.



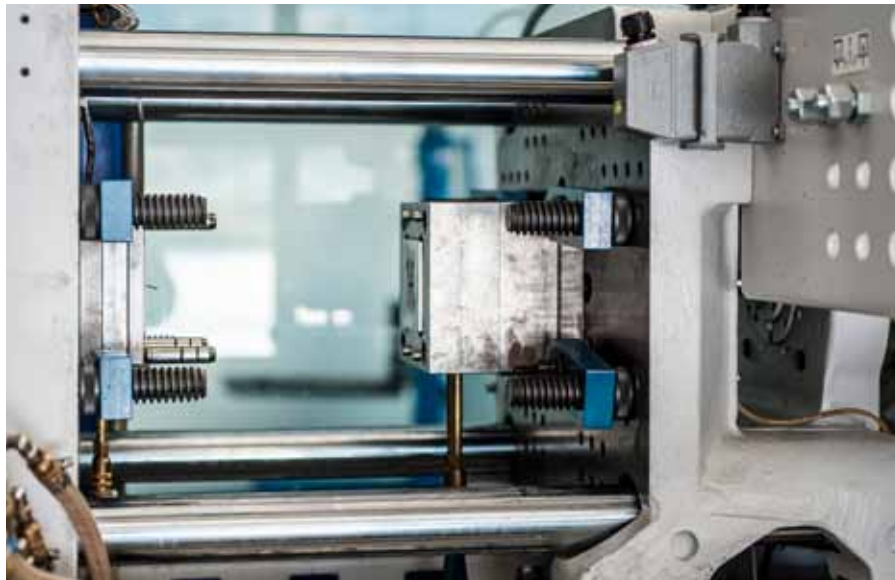
Then the qualitative leap followed, we purchased the raw material directly from the wholesaler. Several investments then took place: the extension of the plant, the purchase of some injection molding machines, and also the purchase of two special ovens in order to have two different production lines and to be able to increase the quantity of the final products – and, as a consequence, also the sales figures, of course.”

Today, the Mimest company has gained pretty much experience with a very wide range of different materials, including steel, bronze, titanium, and many other metals. Last but not least, the production volume achieves 1 million parts a year.

Choosing the MIM technology

The MIM technology allows for the creation of objects in metal alloy with amazing mechanical and appearance characteristics.

It takes full advantage of injection molding, in particular of its high productivity, freedom of geometry, and lightness. Another advantage is the following: when the finished parts' weight ranges from a few grams to 300 grams, there



is no need for mechanical and thermal treatment or surface finishing. "It is a highly competitive technology compared to traditional casting processes, especially when complex geometries or difficult materials come into play. But to amortize the cost of the mold, optimal production often has to be based on volumes of no less than 10,000 pieces," explains Rudj Bardini.

Another interesting detail is that it is possible to produce very small components with aesthetic requirements and very tight tolerances. "A significant project in this sense, for example, concerns the production of hinges and aesthetic micro-parts for a well-known brand of eyeglasses," says Bardini.

One process, three steps

The MIM production process consists of three steps, which include molding, debinding, and sintering. Adding up all of these three steps equals the cycle time of the whole process. From starting the entire working process to the extraction of the first parts for the eyeglasses took approximately three days, while the average lead time of this process is four weeks, without any further surface treatments.

"The injection molding process as such is the one step with less impact on the cycle time," Bardini explains. "For example, the already mentioned micro-parts for the optical sector required a molding cycle time of only 15 seconds, using a 4-cavities mold."

Step 1: Molding

Apart from the screw, the cylinder and a few other accessories, the injection molding machines are the same as those used for the molding of plastic parts. Mimest's MIM equipment consists of a WITTMANN BATTENFELD *EcoPower 55* injection molding machine, equipped with a special MIM/CIM package. The choice of an all-electric machine was made not only because of the possible energy savings, but primarily in considering the strict quality requirements. Only an electrically driven injection unit can guarantee the highest degree of repeatability, which is absolutely crucial for the MIM process. In addition, the sensibility of an electric machine's clamping unit and ejector helps to protect the relatively sensitive so-called green parts.

View of the mold that Mimest uses for the production of components for eyeglasses.

The molded parts – called green parts – are removed from the mold by a robot.

The raw material that is used comes as a mixture of a binder, polymers, wax, and also metal powder that consists of spherical particles with a diameter of 20 micron. These particles represent 92% of the whole feedstock. The material is injected into the mold, where it reaches temperatures ranging from 60–80 °C, but never its melting point. Rudj Bardini explains: "The spherical shape of the metal powder particles avoids the abrasion of the mold. And on the contrary to what one may think, the metal's consistency is rather fragile compared to that of plastic. The molded – or green parts, as we call them – are rather fragile, thus it becomes necessary to furnish the mold with more and bigger ejectors. The removal of the parts is carried out by a robot that

also manages the separation of the parts from the sprues when both are lying on the conveyor belt.” When processing MIM parts, a robot becomes absolutely necessary. Normally, small molded plastic parts are ejected and are free to fall into a box or on a conveyor belt. The green MIM parts, however, are even more sensitive than glass parts, and thus it is impossible to simply let them fall down. Parts removal from the mold is critical. Here, the WITTMANN robot’s control is particularly helpful, offering the possibility of fine-

and robot also come with a data saving function. Intelligent control features – like the *SmartRemoval* function – considerably reduce the cycle time.

Step 2: Debinding

Green parts are then immersed in a solvent for a variable amount of time, according to their sizes. “This step, called primary debinding, permits the removal of one of the poly-

The green parts have the same geometrical characteristics than the finished parts, but bigger dimensions. They are by 15–20% bigger because they contain plastic and waxes. The green parts have to undergo a debinding (or de-waxing) procedure. They are immersed in solvent, and then dried for 10–12 hours in a hot oven that is under vacuum.



After debinding, the parts pass into a sintering furnace where they obtain compactness. The finished part has excellent characteristics and aesthetic qualities, and requires no further finishing treatment.



tuning adjustment of the respective parameters, enabling the gentlest part extraction possible. Furthermore, to avoid parts damaging, precise monitoring of the gripper vacuum is necessary. Thanks to analog Venturi vacuum regulation, every single cycle can be monitored, and it can be ensured that all the parts are completely and correctly extracted from the cavities. The new WITTMANN R8.3 robot control comes equipped with this feature, a highly convenient and helpful tool.

mer elements of the binder – representing 4–7% of the volume – that in the first step helped to facilitate the filling of the cavities”, says Rudj Bardini. Afterwards, the parts are put into an oven at 650 °C, undergoing the secondary debinding.

Step 3: Sintering

Now the parts are put into a sintering oven, where they obtain compactness. Depending on the metal alloy, the temperature in the oven can reach 1,400 °C. Compared to the finished parts, the molded green parts seem oversized. During sintering, the spherical metal particles are compacted, which leads to a reduction of the final parts’ volumes. ♦

Stefano Troilo is a photographer and external consultant of the Italian *PLASTIX* magazine to which he also contributes.

WITTMANN BATTENFELD offers to its customers fully integrated solutions of injection molding machine and robot, allowing for the reduction of the necessary footprint. The complete working cell is CE identified, and machine

"First place" for WITTMANN BATTENFELD *EcoPower* and *SmartPower*

The Swiss company Prewag AG in Eschenbach-Neuhaus, canton St. Gallen, presents itself as a real model company. With its efficient production equipment, it manufactures technically sophisticated, high-quality products for well-known customers. The company operates with machines, automation solutions and peripheral appliances from the WITTMANN Group.

Thomas Robers



Prewag company site in Eschenbach-Neuhaus, Switzerland, viewed from the south. In this picture, the solar panels on the extension building constructed in 2016 can be recognized on the left.

Anyone who has the opportunity to see the facility of Prewag AG immediately notices one thing – here everything is focused on top quality and performance, down to the smallest detail. An impression first gained from the modern, well-kept buildings and subsequently from the high-performance injection molding machines, which are all equipped with handling devices, and finally from the optimal arrangement of the machinery belonging to the various production units. You will not find any injection molding machines standing idle at Prewag. Here, “everything is up and running”.

Prewag AG is a small, but excellent family-owned business, now managed jointly by the two brothers Guido and Roger Guggenberger in the second generation.

In 1992, their father Hermann Guggenberger had acquired the company, which originally processed thermosets by compression molding (the company name Prewag was also derived from the original “Presswerk AG”). Shortly afterwards, the two sons took over the management of the company and developed it to its present size.

Rapid growth

Production takes place today in two modern halls. The first of these halls was built in 2005 together with the office building. The site in the Neuhaus industrial area acquired for this purpose was situated right next to the “Oberland

Motorway” and offered sufficient space for possible extensions. Before moving to this site, Prewag employed seven workers, now there are 25.

The extension hall built in 2016 was planned according to latest ecological and economic principles. The hall is fully air-conditioned and equipped with noise barrier walls and ceilings. Its southern external wall is completely covered with solar cells which supply the complete electricity demand of the hall when the weather is favorable. LED lighting in the entire building and energy-efficient injection molding machines from WITTMANN BATTENFELD make it possible.

The *SmartPower* injection molding machines in operation there are equipped with energy-efficient servo-hydraulic drives which shut down during residual cooling times. With the KERS (Kinetic Energy Recovery System) technology known from Formula One motor racing, the kinetic energy of the moving masses is recovered during the deceleration of all axes, while the hydraulic pump takes over the tasks of the motor and the servo-electric motor those of a generator. Moreover, these machines operate with a low-viscosity HLP32 oil.

This oil heats up much less strongly in operation than the previously used high-viscosity oils, so that less heat is generated and consequently less needs to be dissipated. In this way, the machines can often operate entirely without oil cooling, which leads to a significant reduction of power loss.

SmartPower machines are also very quiet. The speed-controlled servo motor/pump drive generates only as much hydraulic energy as required at the moment and sometimes shuts off completely. It is also very compactly encapsulated and integrated in the machine base, so that hardly any noise penetrates to the outside. Roger Guggenberger, in charge of production and technology at Prewag, comments jokingly: “We could have dispensed with the noise barrier walls and ceilings in view of the low noise level with which the *SmartPower* machines operate.”

Energy-efficient SmartPower and EcoPower machines with KERS energy recovery system from WITTMANN BATTENFELD in the new production hall of Prewag AG, operating with solar energy.

An EcoPower 110/530 with a W818 robot. Standing in front, from left to right: Roger Guggenberger, COO of Prewag AG; Werner Bürli, Managing Director of WITTMANN Kunststofftechnik AG (CH); Guido Guggenberger, CEO of Prewag AG; Thomas Robers, Managing Director of BATTENFELD Schweiz AG.

The customer’s satisfaction with BATTENFELD, however, was not always as pronounced as it is today. The company founder Hermann Guggenberger had started off with machines from BATTENFELD, but their number had declined more and more in the 1980s and 1990s. Until the time when BATTENFELD had been taken over by WITTMANN, when the newly developed machines from the *PowerSeries* caught Roger Guggenberger’s attention, and he made use of the opportunity at the Fakuma 2011 for thorough inspection of an all-electric *EcoPower*. The excellent handling attributes and easy operation of the UNILog B6 machine control system then in use made a very positive impression on him. Immediately after the fair, an order was placed for the first *EcoPower* 55. This machine was followed very rapidly by three *SmartPower* injection molding machines – and subsequently four more from the same series – with clamping forces ranging from 25 to 240 t. “The price-performance ratio is impressive. As far as I am concerned, the *SmartPower* and the *EcoPower* clearly take place one”, says Roger Guggenberger. The most recent delivery was a *SmartPower* 120 in spring 2018.



A selection of typical products made by Prewag.

Broadly based product range

Today, Prewag AG produces parts with a total of 27 molding machines, with rapidly increasing volumes. Orders, however, are not accepted at any price. Prewag specializes in premium-quality technical parts, in which the highly developed injection molding expertise accumulated here is brought to bear. As far as possible, more added value is created too, by additional services such as component assembly, printing, picking and packaging. The product portfolio includes design packaging for large watch manufacturers as well as technical parts for the electrical, sanitary installations,

building construction, household goods, food and machinery industries, also parts for medical appliances and, most recently, dental equipment.

Quality, automation and refinement

In 2013, the company was granted certification according to ISO 9001:2008; Prewag is now also CO₂ certified. Special care is taken with the molds used in production.



exception of a few small models, all machines are equipped with handling appliances or complete automation systems from the WITTMANN Group's subsidiary in Switzerland. The most recently installed production cell to manufacture fully assembled design packages for one of the world's largest watch manufacturers contains an *EcoPower 240* injection molding machine and a *W832 pro* robot with the latest *R8.3* control system, which is mounted on the machine, as well as a *W818* assembly robot.

WITTMANN ATON plus material dryer with FEEDMAX material loaders.

For peripherals, Prewag also relies on WITTMANN. In 2016, two 5-fold drying systems with *ATON plus* segmented wheel dryers were delivered. This equipment enables fully automatic cycles, which make it possible to operate the system continuously in three shifts including nights and weekends.

But there are also some smaller measures which contribute to the company's efficiency – some not so spectacular, and some ingenious. For example, the machines are placed with a fixed side clearance of 1.4 m, as Roger Guggenberger explains. The material flow can thus proceed unhindered, access to the machines and peripherals is not restricted, and the result is an attractive visual impression.

Air-conditioned fire shelter room for mold storage at Prewag AG.



An even more creative approach was required, when some persistent streaks on the surface of a molded part made of fiber-reinforced material could not at first be eliminated. The suspected cause was fiber glass dust in the raw material.

It was immediately decided to purchase a special dust extraction unit, a clever investment which actually helped to make those streaks disappear from the surface. A pleasant side effect was that the traces of wear showing on the parts of the machine and the mold which come into contact with the melt were significantly reduced.

Fully automatic production cell for watch packaging, consisting of an EcoPower 240, a W832 pro robot and a W818 robot.



A small stock of machinery for mold maintenance is available in-house. In the new building, a separate, air-conditioned fire shelter room has been installed to house the store of molds.

For quality inspection, a 3D coordinate measuring machine was recently acquired, with which both optical and tactile measurements can be carried out. The latest additions to the company's equipment are a laser marking system and an automatic assembly machine. With the

Conclusion and outlook

With commitment, expertise, creativity and a certain amount of readiness to take risks, Prewag AG successfully is successfully maintaining sustainable growth in the highly competitive Swiss injection molding environment. For instance, 2017 turned out to be the best year so far in corporate history. And the prospects for the future are more than just good. ♦

Thomas Robers is the Managing Director of **BATTENFELD Schweiz AG** in Volketswil.

How Midwest has used robots from WITTMANN BATTENFELD

Everything in its place: with the help of their local WITTMANN BATTENFELD Tech Center, Midwest Molding has integrated their robot configurations into their vision for a fully optimized footprint on every machine.

Bob Arsenault

Midwest Molding Inc. is a family-owned, custom injection molder, specializing in producing high quality, complex manufactured components and assemblies. Established in 1996 and located in Bartlett, Illinois, about 30 miles west of Chicago, Midwest Molding primarily molds parts for the automotive industry. Plastics molding for the automotive industry is highly competitive, and to succeed, Midwest Molding has implemented lean manufacturing principles, maximized its square footage, and prided itself on accomplishing difficult tasks that other companies have turned away from.

Efficiency, efficiency!

Everything that Midwest Molding does starts from an efficiency mindset. They enthusiastically utilize lean manufacturing practices, and do everything possible to ensure as little downtime as possible. In 2005, after being awarded a new program that would require 2.2 million lbs. of resin, they began an in-house design of a new facility that would be custom-built to meet their company's needs and to be as efficient as possible. It was an exceptionally energy-efficient building, with thick walls and ceilings to keep the extreme cold and heat of the Midwest at bay, and all the water and electrical was run underground to conserve floor space and make for easier addition of new machines as they grew.

The new facility was built in 2007, and the entire company moved into it in under one month, a startlingly fast move that proved to their customers that downtime was simply not an option for this company. Fortunately for Midwest Molding, they had diversified their work enough that when the Great Recession hit just one year after construction of a brand new headquarters, something that could have, and did, sink many other companies, they made it through with

very few issues, even purchasing 17 new molding machines as early as 2010 to support new business. "We are committed to always meeting our customers' expectations of us," says Sanjay Patel, Director of New Business Development at Midwest Molding. "We swap out our IMM's every 7–10 years to ensure we are up-to-date on the latest technology and once we hit 70–75% utilization in our plant we buy a new machine. If we are close to 100% utilization, we are susceptible to downtime if anything goes wrong, and our customers have really loved our commitment to making sure we have that extra insurance to make sure that we won't make excuses and downtime simply won't happen."



Close-up of two of the WITTMANN robots Midwest Molding is using at their Bartlett, Illinois plant.

An assist from a local supplier

Once the new facility was up and running, business was booming for Midwest Molding, and they soon needed to expand their capacity and add more molding machines. After having already designed and built their brand-new facility in 2007, expanding or moving to a larger facility was a costly option, and they wanted to continue to be able to take advantage of the productivity-enhancing features of the building that they designed themselves.

By 2015, they knew they had to do something to allow for more efficient space usage, and with molding machines relatively fixed in the footprint they utilize, they invited in a WITTMANN BATTENFELD representative from the local South Elgin, Illinois Tech Center to research possible ways in which they could conserve space with their robots and automation. Every IMM at Midwest Molding included a robot, with zero manual picking done in the facility, so

they knew this was a process that, if improved, could reap substantial rewards. WITTMANN BATTENFELD was instrumental in helping Midwest Molding to make the most of the resources at their disposal and expand their efficiency mindset to include their machines' footprints.

A simple switch

Midwest Molding had been using WITTMANN robots since 1999, and as a result had a strong relationship with the WITTMANN BATTENFELD employees from the local Tech Center. So, when they needed a solution on how to optimize their footprint, they called up Bob Arsenault, WITTMANN BATTENFELD's Regional Sales Manager for Robots.

"Probably the biggest advantage of using the WITTMANN robots is the fact that Bob is right around the corner from us," says Samir Patel, CFO/Controller at Midwest

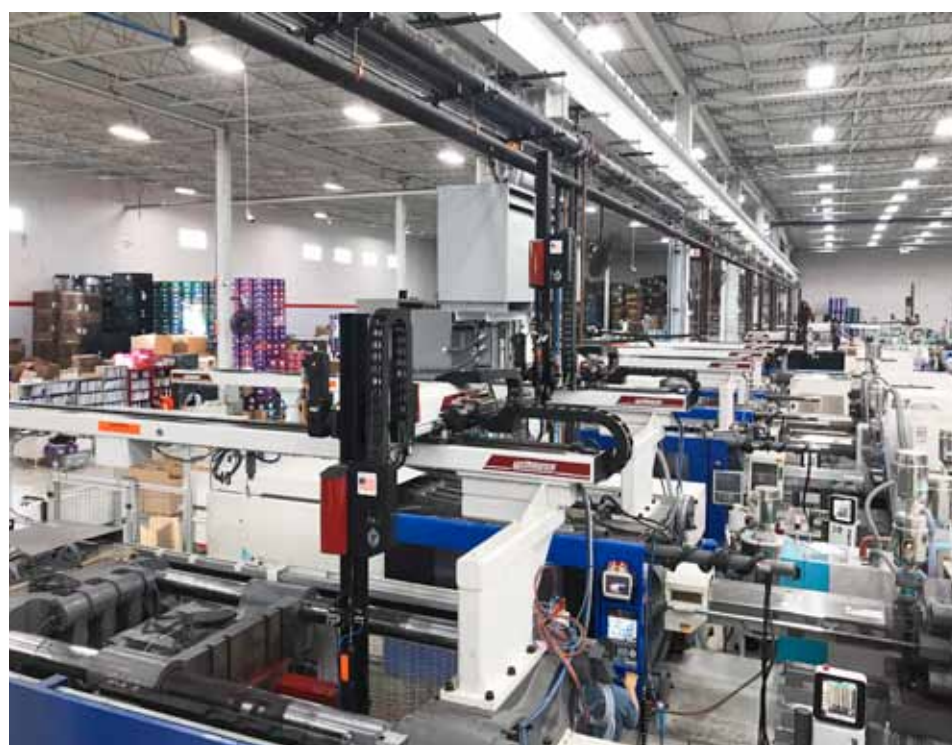
added the A/C-Servo flip and rotation wrist to all the new robots they purchased. This feature helps the robot make the most of the space it is given, providing a solution for complex jobs in tight areas.

More than just the footprint

The benefits of the WITTMANN robots continue beyond the smaller footprint, however, with some of the extra features that they provide adding even more efficiency.

"The programming on the WITTMANN robots is a real advantage," says Mayur Patel at Midwest Molding. "The open architecture allows us to program complex, customized processes how we want them, and some of the built-in features like *SmartRemoval* and *EcoMode* allow us to easily ensure efficient, cost-saving usage of the robots. The robots are smart, which allows for less chance for human error. With *EcoMode*, if we lengthen the cycle time on a machine, the robot will automatically adjust itself to run more slowly and smoothly to save energy, as well as wear and tear, and not be needlessly rushing to sit at the mold and wait for it to open, and with *SmartRemoval*, the robot is tied directly into the machine processes and will enter and exit the mold in the most efficient and timely manner possible without relying on the operator to program that in."

The WITTMANN BATTENFELD Tech Center being nearby has also provided added benefits to Midwest Molding beyond the spare parts and support, including ease of training. "We've seen at



Long view of Midwest Molding's shop floor, with WITTMANN BATTENFELD robots on every molding machine.

Molding. "If we need anything, he is always willing to come over and help us whether it's a technical fix or a consultation on what we could upgrade."

The solution that Arsenault, Patel, and the rest of the Midwest Molding team arrived at was a simple one. Instead of using the traditional mounts for the robots, which track outward from the IMM and necessitate multiple extra feet of floor space to the side of the machine, they would use L-mounts, which run the robot tighter to the machine, requiring less clearance and allowing the IMMs to be placed closer together.

This change, which seems relatively small and simple, reaped enormous benefits in terms of space saved, conserving over 50% on its footprint compared to the alternative configuration. Midwest Molding is now running 55 IMMs, and has the space to fit up to 25 more without any costly new construction. To ensure that they could still have the flexibility to take on the toughest jobs, Midwest Molding

least 25% of their people come in to be trained at our South Elgin Tech Center," says Bob Arsenault. "They really see the benefit of having their people get proper training to ensure correct use of their machines, and the fact that we're right around the corner has made it easy for them to send their employees in to get top-notch training."

"WITTMANN BATTENFELD really is a one-stop shop, and we really see the benefit of that," says Sanjay Patel. "Not only are their robots easy to use, consistent, and solid, everything we have to do with them, from maintenance to training to upgrades, is easier when it's all from the same supplier, and even more so when that supplier is local, friendly, and accessible."

With increasing capacity and a commitment to zero downtime, Midwest Molding sees continued growth in their future, and with their commitment to efficient and high quality practices, the sky is the limit for what this molder is capable of. ♦

Bob Arsenault is Regional Sales Manager Robots at WITTMANN BATTENFELD, INC. in Torrington, Connecticut, USA.

Natural fibers straight from the dryer

Moisture contained in the wood cell walls of WPC evaporates during the extrusion process and causes defects in the end product. These drawbacks can be eliminated by pre-drying the granulate. In a test series conducted by IFA-Tulln, the Institute for Natural Materials Technology at the University of Natural Resources and Applied Life Sciences in Vienna, a WITTMANN ATON dryer was used.

Eva Sykacek – Micha Poszvek – Paulina Rivière – Norbert Mundigler

Reinforcement of thermoplastic materials with wood flour or other natural fibers offers a number of advantages compared to the use of traditional fillers such as fiberglass or mineral reinforcing materials. Biobased fillers come from renewable sources of material and thus contribute to the sustainability of products manufactured from them. By comparison with synthetic fillers, natural materials have lower bulk densities, are CO₂-neutral, biodegradable and in most cases cheaper than artificial fillers.

Wood-plastic-composite (WPC) profiles are widely used today in outdoor and indoor applications, for example as facade elements, wall cladding or terrace decking.

WPC profiles are mostly produced in a two-stage process. First, the wood flour is mixed with the plastic melt to form a homogeneous blend, then compressed and granulated. Subsequently, it is extruded into endless profiles.

For the production of WPC profiles, almost exclusively counter-rotating twin screw extruders are used. The reason for the widespread use of twin screw extruders, which are substantially more expensive than single screw extruders, are the provision of degassing units as standard, their high throughput rates and better mixing and homogenizing performance.

In single screw extruders, the material transport is effected by the adhesion of the melt to the barrel and screw, which move relative to each other (chain-pulled transport). The lack of degassing facilities is an additional drawback for single screw extrusion of materials containing cellulose fiber and/or hygroscopic components.

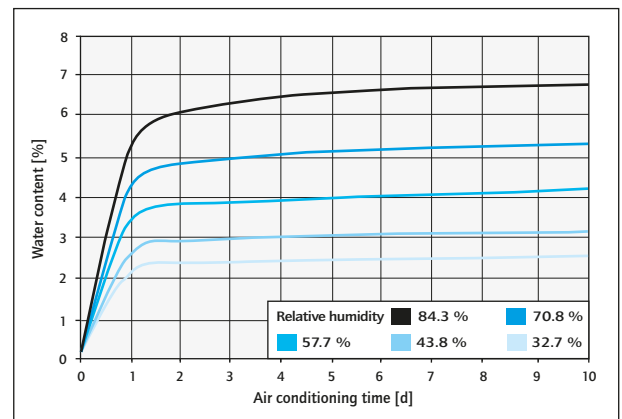
Hygroscopicity of wood and WPC compounds

Depending on the temperature and relative humidity of the ambient air, a certain moisture equilibrium is established inside the wood. Through chemisorptions, which takes place primarily at wood humidity rates between 0 and 6%, the water molecules are stored via hydrogen bonds with the hydroxyl groups of the cellulose between the neighboring cellulose chains. In the further course of moisture absorption, at humidity rates from 6 to 15%, the water is stored inside the cell walls primarily by physical sorption.



Extrunet single screw extruder with profile die.

Illustration of water absorption capacity of a dried PVC granulate reinforced with 50% wood flour, dependent on relative humidity and duration of storage at 23 °C.



Capillary condensation takes place mainly at wood moisture rates above 15% until the cell walls are completely saturated with water. The lower the water content, the higher the bond energy of the water stored inside the cell walls.

In spite of the wood particles being covered with plastic, a certain moisture equilibrium corresponding to the ambient climate is still established in WPCs. The storage of dry wood-PVC granulate in dry air (32.7% relative moisture) leads to an increase in the granulate's water content to 2% within 24 hours. An 84% moisture content of the ambient air causes an increase of the water content to more than 5% over the same period of time.

During WPC extrusion, the water stored inside the wood cell walls evaporates, due to the high processing temperatures. Bubbles and cavities are formed in the end product, especially if there are no degassing facilities. The water bonded at the fiber surface also functions as a separating agent between the cellulose filler and the polymer matrix. Both these factors cause a significant loss of strength in the end product.

Single screw extrusion of granulate with different moisture content levels

At the Institute for Natural Materials Technology (IFA-Tulln, University of Natural Resources and Life Sciences, Vienna/Austria) the effect of water content in WPC single screw extrusion was examined, as well as optimization potentials with an ATON 2 F120 segmented wheel dryer from WITTMANN.

A PVC blend reinforced with 50% wood flour was compounded in a co-rotating conical twin screw extruder, and the granulate was then brought to water contents of 2, 1 and

Loss of strength through 1% water

The flexural strength of the profiles produced at low throughput rates is reduced by 28% when using the moist wood-PVC granulate. With higher screw speeds, the effect of the water is even more pronounced. Here, the flexural strength is reduced by 48% when granulate with 1% water content is used. In view of the higher throughput rates which can be reached with simultaneous assurance of good product quality and process reliability, it makes sense to use continuous granulate drying in WPC single screw extrusion. Due to positive past experience, an appliance from the

WITTMANN Group was again chosen for this purpose.

The ATON 2 F120 is specially designed for drying plastic granulates at drying temperatures ranging from 80 to 130 °C.

The drying silo has a capacity of 300 l. In contrast to circulating air dryers, this appliance offers consistent drying quality even when the climate of the ambient air changes, thanks to using dry air. The dry air flows upwards through the granulate and is subsequently demoi-
sturized by a desiccant.

Depending on the requirements for drying quality and/or energy efficiency, the dryer can operate either in the segmented wheel mode or in the tower mode.

In the wheel mode, the drying wheel divided into 36 chambers rotates

with a constant speed of about one revolution per hour. The return air from the drying silo flows through the chambers and is demoi-
sturized by the desiccant contained therein. In this mode, most of the chambers are involved in the drying process and only few chambers are in the regeneration zone, where the desiccant is regenerated. Part of the air for regeneration comes from the process heating system and thus leads to a higher starting temperature with higher water absorption capacity. In the tower mode, the drying wheel does not rotate continuously but is only turned by several segments after a certain period of time. A major advantage in drying WPCs, which are more sensitive to heat than pure plastics, is the material protection function integrated in the system.

The protection principle is based on the energy consumption of active drying. The temperature of the air flowing back from the drying silo is measured continuously. As soon as the granulate is dry, or absorbs no more energy, the temperature of the return air rises. When the set threshold value is exceeded, the drying temperature inside the silo is lowered to prevent thermal damage to the granulate.

Temperature sensitivity of wood and PVC

Slight thermal degradation can already be observed in wood after it has been exposed to temperatures of 80 to 100 °C for any length of time. But more substantial decomposition only sets in at temperatures above 180 °C. Hemi-

Profiles produced with screw speeds of 60 rev/min; surfaces (top) and cross-sections (bottom) from wood-PVC granulates with moisture contents of 2% (left), 1% (center) and 0.1% (right). – Cracking, formation of bubbles, good product quality (from left to right).

*Table:
The flexural attributes of the profiles produced with granulate moisture levels of 1 and 0.1%, measured according to ISO EN 178. Flexural strength, strain and elasticity moduli of the bar profiles dependent on screw speed (throughput) and granulate feed moisture. The standard deviations are shown in brackets.*

The WITTMANN ATON F120 dryer installed at the Institute for Materials Technology with a WITTMANN FEEDMAX material loader.



Screw speed (rpm)	Throughput (kg/h)	Water content resin (%)	Flexural strength (MPa)	Bend twist (%)	Bending-E-module (MPa)
10	6	1.0	34.4 (1.6)	1.29 (0.10)	3030 (746)
60	30	1.0	23.3 (5.0)	1.89 (0.72)	1385 (659)
10	6	0.1	47.7 (2.3)	1.20 (0.08)	5045 (494)
60	30	0.1	44.9 (2.2)	1.28 (0.06)	4705 (236)

0.1% respectively. A coextruder was used for the single screw profile extrusion process. The latter was equipped with four barrel heating zones, one adapter and two heating zones for tooling, as well as a standard screw with an L/D ratio of 23.

The granulates with different moisture contents were each extruded with screw speeds of 10 and 60 rev/min into bar profiles (40 × 6 mm).

When using the granulate with the highest moisture content, the resulting steam pressure is so high that the profiles are torn into small pieces. Using granulates with a 1% water content still allows the production of endless profiles, but leads to the formation of a considerable amount of bubbles in the profile cross-section. However, when the granulate is dried to 0.1% moisture content, a good product quality is achieved even at high throughput rates of more than 30 kg/h.



cellulose is the wood component with the lowest temperature resistance of all wood components. A large part of it is rapidly degraded at temperatures of 200 °C. Maximum decomposition of cellulose takes place at temperatures around 280 °C. The thermal decomposition of lignin proceeds in several stages at temperatures between 240 °C and 260 °C.

PVC is very sensitive to higher temperatures. During the thermal decomposition of this material, various degradation products are formed, such as hydrochloric acid. The major part of PVC is decomposed at temperatures between 245 and 370 °C. A thermo-gravimetric analysis (TGA) was carried out on the 50% wood flour-PVC compound to be sure to exclude all technical risks.

At temperatures of up to 180 °C, a 2.5% loss of material mass can be measured, which roughly corresponds to the water content of the sample.

At temperatures below 300 °C, the sample has been degraded by more than 30%, with the highest degradation rate at 280 °C. This loss of mass is mainly due to decomposition of the wood component. At temperatures above 340 °C, the thermal decomposition proceeds much more slowly. At 360 °C, the total loss is a little more than 55%. Only at temperatures of 600 °C was the sample degraded to a residual mass of 5.6%.

A drying temperature of 130 °C is well below the thermal degradation temperatures of the wood-PVC compound tested.

Thermal loss of mass and degradation rate of 38.5 mg of the WPC compound within a temperature range from 20 to 600 °C.

Results of the drying tests: water content of the granulates dependent on time, drying temperature and related return air temperatures.

Drying gradient after 6 hours of drying at 110 °C (left) and eight hours of drying at 80 °C (the chemical control measurements are marked in blue).

Eva Sykacek
(Research Associate),
Micha Poszvek,
Paulina Rivière,
Norbert Mundigler
(Institute Director): Institute for Materials Technology, IFA-Tulln, University of Natural Resources and Applied Life Sciences, Vienna.

Preparation of drying curves

To optimize the extrusion process in terms of product quality, throughput and energy costs, it is necessary to create a material-specific drying curve.

For this purpose, the dryer was filled with moist wood-PVC granulate and set at drying temperatures of 80 °C and 110 °C. At half-hourly intervals, samples were taken from the bottom part of the dryer to measure the water content. The samples were analyzed by double determi-

nation. The results were checked at random by chemical testing as well. The water was extracted from the samples by storing them for more than two weeks in anhydrous methanol. The water content in the resulting extract was subsequently examined in an aliquot according to Karl Fischer. In this titration, sulphur dioxide is oxidized by iodine in the presence of water into sulphuric acid, and the

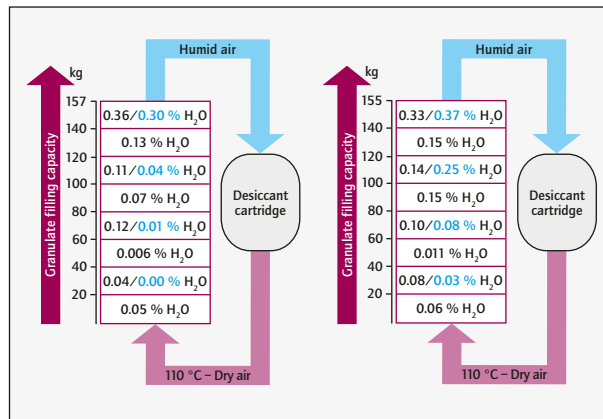
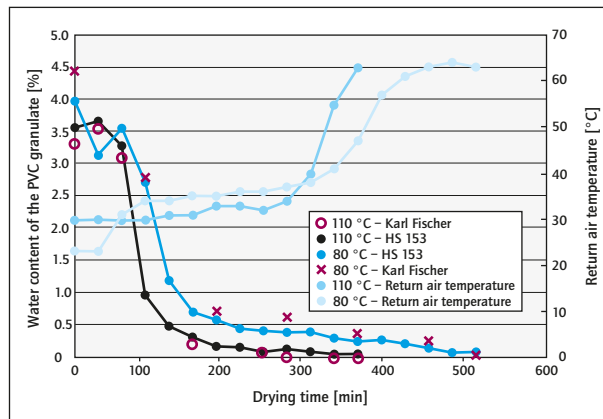
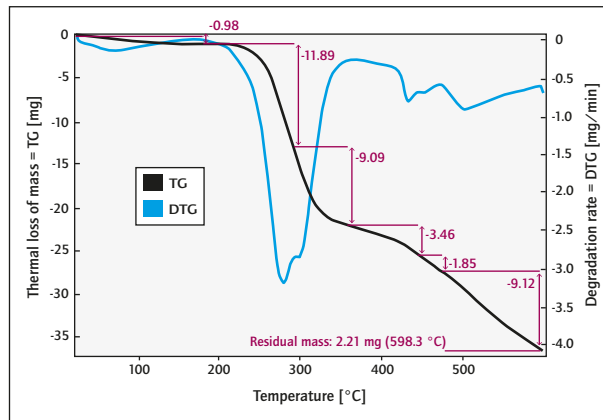
iodine is simultaneously reduced to hydrogen iodide. The endpoint is determined electrometrically. The lower quantization limit is at 50 to 100 ppm. About 2 hours after a water content below 0.1% had been reached, the dryer was turned off, and the moisture gradient measured in layers of 20 kg.

A drying time of just 2 hours at 110 °C reduces the water content of the granulate in the lowest drying layer from above 3.5% to below 0.5%. After four hours, the material has been dried to less than 0.1%. From 270 min drying time onwards, all chemically measured control points show a 0% water content. When the drying temperature is set 30 °C lower, the granulate is dried from a 4.4% water content down to below 0.5% after three and a half hours. At a drying temperature of 80 °C, it takes a drying time of eight hours to reach a granulate water content below 0.1%, that is almost twice as long as at the higher drying temperature.

The integration of ATON F120 in a continuous single screw WPC extrusion process requires knowledge of the water content in the entire drying silo. According to the measured values,

140 kg of dry granulate with a maximum water content of about 0.1% is available after a drying time of 6 hours at 110 °C. At a drying temperature of 80 °C, there is also a relatively low downward gradient in moisture content. The lowest 80 kg layer inside the drying silo shows a water content below 0.1%.

The integration of an ATON F120 in single screw WPC extrusion enables the production of high-quality profiles with throughputs far above 23 kg/h at 110 °C drying temperature. A drying temperature of 80 °C allows a minimum throughput of 10 kg/h. ♦



Vignesh: highest quality through WITTMANN

Within a decade of the company's establishment, Vignesh Polymers emerged as one of the fastest growing organizations in southern India. The company supplies the automotive and appliances industries, producing high-quality injection molded parts for some of the globally most celebrated OEMs.

Ram Kumar

Highly regarded by its customers, Vignesh Polymers has recently been the proud recipient of numerous awards, including being named *Best Vendor* by Samsung, and receiving the SQ Certification from Hyundai Motors – just to name a few of the many recent accolades and prizes.

Vignesh Polymers runs two production plants located in Chennai and Goa and operates some 40 injection molding machines ranging from 180 to 1,300 tons. These are equipped with robots, mold temperature controllers, drying and conveying units, and other auxiliaries from the WITTMANN Group.

The founder and CEO of the company, R. B. Sivakumar, a graduate from the Central Institute of Plastics Engineering & Technology (CIPET), is a first generation entrepreneur – ever determined to further develop the company. Relying on his excellent technical skills and working experience in Korea, Taiwan, and for various industries for more than two decades, R. B. Sivakumar points out that “in any process, there will never be a proper output without the right input.”

In today's competitive world he also insists on the need for state-of-the-art equipment. This should not only outperform competitors, but also be able to harmonize growth plans within the company.

“Our entire infrastructure has been carefully planned out in order to meet the global standards demanded by international manufacturing companies.”

Vignesh Polymers and the WITTMANN Group

He adds that “we want to be seen in the industry as a perfect technical partner for plastic injection molded components. Since most of our components are of highly engineered plastic materials, we sought automation at an early stage. We started working with the WITTMANN Group, purchasing a W828 robot for the automation of a workcell making parts for the white goods sector. This was a really convincing experience, and well-received by our customers. This success encouraged us to keep going with automation. Within a couple of years, we ended up running

almost all of our machines with dedicated automation cells. There is perhaps a general assumption in Indian plastics that working with automation costs more than manual operator handling. In the long run we know this not to be the case.”

R. B. Sivakumar says that Vignesh Polymers is constantly looking for innovative production processes. Having learned from its first automation projects, Vignesh Polymers then wanted to go further; handling all sorts of complex components and bringing about the need for EOAT solutions and for flexible robot programming. “The Indian WITTMANN Group team geared up to meet all of Vignesh's expectations within the shortest time possible. The WITTMANN team equipped our company with customized EOAT and with special programming solutions for the robots,” says R.

B. Sivakumar. In addition, key automation features such as *SmartRemoval* and *SoftTorque* were highly appreciated and also helped to further shorten the cycle times.

In fact, using WITTMANN automation turned out so well for Vignesh Polymers that the company shifted in favor of a closed-loop molding strategy. The Vignesh business began to purchase other auxiliary equipment from the WITTMANN Group: mold temperature controllers, low speed granulators from the JUNIOR series, material loaders, and a dew-point controlled DRYMAX E300

battery dryer with multiple drying hoppers. And having integrated all of these components, better quality rates were achieved, and manual intervention was decreased.

Future perspectives

R. B. Sivakumar says that the Indian molding industry in general may yet take some time to fully adopt advanced concepts such as *Industry 4.0*. However, at Vignesh Polymers, the adoption of *Industry 4.0* concepts has already begun. Real-time data from all the machines is collected and assessed. Integrated mobile apps help to bring together the status of each machine and its process parameters.

Alarm indications and the efficiency of the entire process can be easily checked; enabling quick decisions and assuring the highest degree of transparency to the company's customers. This approach gives Vignesh an increasingly competitive edge. This is also one of the reasons why Vignesh Polymers has become a preferred vendor for multinational OEM's.

R. B. Sivakumar expresses his total satisfaction with the WITTMANN Group's equipment, and is also looking forward to evaluate WITTMANN BATTENFELD injection molding machines – as part of the company's equipment in the near future. ♦



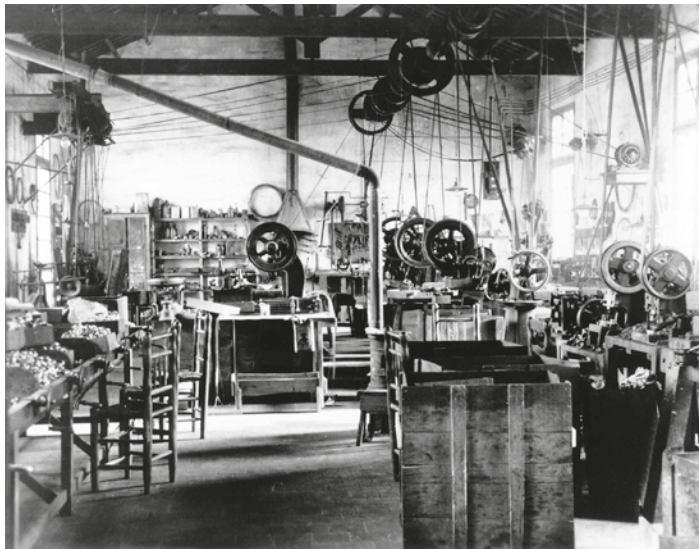
R. B. Sivakumar, founder and CEO of Vignesh Polymers (left), in the Chennai production facility with Ram Kumar, Sales Manager for South India of WITTMANN BATTENFELD India pvt Ltd., the Indian branch of the WITTMANN Group.

Ram Kumar is the Sales Manager for South India of WITTMANN BATTENFELD India pvt Ltd. in Chennai.

Spanish lighting specialist counts on the WITTMANN Group

Simon was founded by Arturo Simon in 1916 in a little workshop in Olot (Girona Province, Spain). The initial step the company took was the manufacturing of lampholders – due to the scarcity of this product during World War I. Little by little, the range of products was extended and in the fifties, the small workshop had become Simon's first big factory. Today, the Olot headquarters of the Simon Group has 15,000 m² of floor space – and Simon has become an important customer of the WITTMANN Group.

Mary Gómez – Antoni Pujol



Views of the Simon production facility in Olot, Spain – then and now.



Over the years, Simon has acquired several complementary companies, opened new subsidiaries in different countries, and contracted cooperation agreements with other important groups of companies. Thus, the activities of the Simon company have become diverse, and the company has realized substantial growth because of it.

Simon's expansion

The Simon Group represents one of the most important multinational companies headquartered in Spain, operating in 90 countries worldwide. A family owned business to the present day, currently the 4th generation of the Simon family is leading the enterprise.

The Simon Group's biggest production facility, with a floor space of 60,000 m², is located in Hai'an, China, employing a staff of 1,100. The product portfolio ranges from on-off switches (especially collections of light switches) and connection systems for workstations to control systems, interior and exterior lighting, and recharging equipment for electric vehicles. The continuous investment in growth has resulted in more than 3,900 collaborators worldwide, of which 800 are employed in Spain. One in every ten employees is professionally dedicated to R&D. The year 2016 was a very important one for the Simon Group, as the company celebrated its

centennial, putting much emphasis on their main aim, which is to remain a family business, and to furthermore set the benchmark with their products wherever these are being used.

Simon's WITTMANN Group equipment

Over the years, Simon has introduced WITTMANN BATTENFELD equipment into their manufacturing plants to realize the highest possible quality and production efficiency. Today, Simon production equipment includes injection molding machines with different clamping forces, temperature controllers, and material drying and conveying equipment as well as palletizing units. All of this equipment is facilitating the production process and contributing to optimal and efficient results.

One of the special reasons as to why Simon counts on WITTMANN BATTENFELD lies in the production of a 3-element frame as part of a light switch from Simon's 24 Harmonie collection – a product that is sold on the Moroccan market. In the case of this special part, there were some difficulties to overcome in regard to the execution of the injection process. The visual impression of the molded part suffered heavily from a lack of gloss, and also the burrs could be clearly seen – altogether, the initial outcome was a part that was utterly impossible to be sold. After testing some other approaches, the WITTMANN TEMPRO plus D140

dual zone temperature controller proved to be the solution. The use of this unit made it possible to bring the gloss of the final part to perfection, and to also eliminate its burrs. In order to come up to a part with a perfect aesthetic appearance free from defects, it is absolutely essential to dry the plastic resin. This was done using a compact WITTMANN DRYMAX E30 dry air dryer. All in all, the successful final outcome was the result of the very close cooperation between the WITTMANN Group and the Simon specialists.

Success through cooperation

The Simon Group – as a multinational company – is constantly investing in the latest manufacturing technologies and production processes. One of many current ex-

amples is the latest acquisition of a WITTMANN W818 robot for the company's production plant in Martorelles near Barcelona.

For many years now, the Simon Group has trusted in robots from WITTMANN and also WITTMANN sprue pickers, automating the processes in different production plants. Finally, this essential cooperation contributed to Simon's success in the fields of interior and exterior lighting.

Simon is a real reference point for the entire industry in its innovative capacity and the development of new business lines. This is reflected in the fact that Simon continuously patents very many products, leveraging the company's ability to create new ideas and solutions. ♦



Hydraulic injection molding machine from WITTMANN BATTENFELD, and automation and drying equipment from WITTMANN at Simon in Olot.

Mary Gómez and Antoni Pujol are collaborators of the Simon Group.

The S-Max series of screenless granulators

August 2018 will see the new S-Max granulator models from the WITTMANN Group available for delivery: S-Max 2, S-Max 2 Plus, and S-Max 3. These are low speed granulators for the inline-recycling of sprues made of hard and brittle engineering resins. Depending on the granulator model, a material throughput of 12, 20 or 30 kg/h can be reached.

Denis Metral

The past twenty years have seen a shift in the attitude and practice of plastics processors to waste – in regard to both their own in-house waste, and also in using plastics recycle in finished products. Choosing a granulator or particle resizer can be critical to success.

Clearly increased environmental considerations have played a part in these developments. “Green” factors continue to come to the fore. Not only that but plastics processors are also making greater efforts with regard to in-house recycling and material savings. Companies are realizing that they too must also keep up with current social trends. Many end-user customers today are asking for products made from recycle. It makes good business sense to supply them with the same.

The new S-Max 2 granulator from WITTMANN.

Aspects of granulators

Most processors need a constant quantity of dust-free and high-quality regrind at a constant size. This is the main priority. But there are of course some more important issues: dust sealing, modular design, easy and safe cleaning, efficient and effective power drive design, low noise and compact footprint. Operational safety is also very important.

WITTMANN has therefore developed several industry “firsts” to meet these criteria; WITTMANN granulators produce less noise, save more energy, have a more compact footprint, need less maintenance, are equipped with hardened cutting tools, provide for easy cleaning and maintenance, and also have excellent safety features.

S-Max series granulators

The S-Max series models are specifically designed for the closed-loop recycling of sprues/runners from injection molding machines with up to 300 tons of clamping force.

The S-Max is a portable piece of equipment which allows for great versatility and can be moved easily from one molding machine to another.

These granulators allow a new way of working: Firstly, a remote control replaces the fixed electrical control panel that normally is used on granulators. This new functionality allows for standard functions that are not available with traditional granulator design. For example, the control device has an hour counter with a digital display, helping to fix the appropriate maintenance date. An interface also enables full communication with the injection molding machine. As an option, a special shutdown-function is available: When the injection molding machine is “off”, the granulator stops automatically, helping saving energy. There are also two different possible positions of the control panel on the granulator to choose from, making it much easier for the operator to supervise the grinding process. The control’s connecting cable to the granulator has a length of three meters, and this feature allows the control of the granulator from outside a protective housing. In contrast to competitor products, WITTMANN offers this feature as a standard.



	S-Max 2	S-Max 2 Plus	S-Max 3
Cutting chamber	240 x 249 mm	240 x 346 mm	240 x 467 mm
Number of knives	2	2	3
Motor power	1.1 kW	1.5 kW	2.2 kW
Rotation speed	30	0.1	4705 (236)
Throughput	12 kg/h	20 kg/h	30 kg/h
Regrind size	4 – 5 mm	4 – 5 – 7 mm	4 – 5 – 7 – 10 mm

Standard features

Many more interesting and advantageous features of the new S-Max Series come as a standard. A high level sensor gives visual and audible alarm if necessary, and is located underneath the cutting chamber, thus avoiding the overfilling of the bin, and also keeping the cutting chamber free from regrind. This position of the sensor brings about some

additional advantages: direct wiring to the electrical cabinet, the sensor’s head not being amidst the material, and full inlet capacity of the bin.

The swivel outlet pipe can take different positions, making it easier to connect the flexible hose to the hopper loader. This typically allows for a more efficient use of the floor space next to the machine. The slanted, front cut outlet pipe with adjustable airflow evacuates the regrind more efficiently and also avoids the blocking of the flexible hose. The granulator is equipped with an easy-to-read hour counter log on the remote pendant allowing for exact maintenance planning. A good access to the cutting chamber is given from above via the 90° tilting hopper to allow an easy perfect cleaning. ♦

* Depending on material, shape, density of sprues/parts to be processed, and regrind size.

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WITTMANN BATTENFELD India pvt Ltd. still growing

Founded in 2007, the Indian WITTMANN Group subsidiary has steadily grown. Today, the company works with a team of 70, serving more than 1,000 customers all over the country.

The recently expanded Chennai headquarters provides 420 m² of office space and 1,320 m² of production and storage area.

As well as being the market leader for robots in the Indian plastics industry, WITTMANN BATTENFELD India is also widely recognized for all other products in the WITTMANN Group portfolio: dryers, conveying systems, and mold temperature controllers. Above that, the company excels in building customized downstream automation and special gripper solutions.

At this year's Plast India show, WITTMANN BATTENFELD India received the award for the Best Performing Enterprise. Proximity to customers and an all-embracing and prompt service make for short delivery times and a high degree of customer satisfaction. The Indian market still shows a promising future: In the last



The team of WITTMANN BATTENFELD India pvt Ltd, the Indian branch of the WITTMANN Group, based in Chennai.

two years, the Indian branch has grown by 18% annually, not least due to the very strong automotive and white goods markets that themselves are posting growth figures of 20%.

The Indian plastics industry is also further investing and upgrading to better technology and equipment safety, and even, to some extent, to *Industry 4.0* concepts. WITTMANN BATTENFELD India has already sold its first injection molding



View of the Indian subsidiary's enlarged premises.

machine with fully integrated robot and temperature controller, a system that also deploys the benefit of *WITTMANN 4.0* technology. ♦

Fourth extension of WITTMANN BATTENFELD Mexico

With growth rates well above 20% over the last few years, the Mexican WITTMANN subsidiary has developed into an important location within the group. The year 2017 was no exception, although the prospects for the future were viewed with some skepticism at the beginning of the year, due to the strained political relationship with the neighboring USA. However, this skepticism proved groundless within a very short time, and Mexican investment activities continued unabated throughout the whole year.

The WITTMANN subsidiary in Mexico was established in the centrally located Mexican city of Querétaro exactly 20 years ago and has grown steadily ever since. In this anniversary year too, its headquarters are now being extended for the fourth time by 950 m² to a total of more than 3,000 m² floor space. The present extension is dedicated specifically to the office

facilities to provide sufficient space for the now more than 75 staff members. The Mexican subsidiary offers the complete service portfolio to local customers – from quoting and project planning to commissioning. A train-



ing center has also been established at the headquarters of WITTMANN BATTENFELD México, equipped with a servo-hydraulic *SmartPower* and an all-electric *EcoPower* machine. Robots from the W8 series for training and programming purposes are available too, together with peripher-

als for temperature control, drying, materials handling and blending, as well as granulators for demonstration purposes. To meet the rising demand for automation equipment, WITTMANN BATTENFELD México already started several years ago to build up its own local automation group. Apart from the Querétaro headquarters, WITTMANN has established additional sales and service facilities over the years in México City, Guadalajara, Monterrey, Reynosa, Chihuahua, Ciudad Juárez and Tijuana. This ensures complete coverage of all plastics processing companies located anywhere in Mexico.

The CEO of WITTMANN BATTENFELD México, Mr. Rodrigo Munoz, comments: "The extension was started in February of this year and will be completed on schedule in July. Of course, WITTMANN BATTENFELD México will celebrate the official opening with its customers on completion." ♦

WITTMANN BATTENFELD México S.A. de C.V., view of completed building by July 2018.



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