An Economic Miracle in Brush-Land

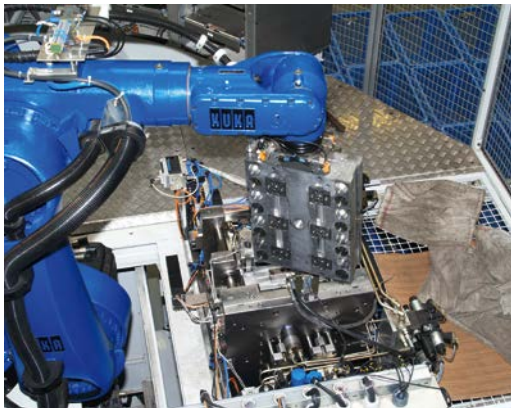
The Plastics Processor Bürstenmann of Saxony, Germany, as a Pilot Customer of Zahoransky, Goes for Innovation.

In 1991, the management consultant Roland Berger recommended selling off what had formerly been the biggest brush manufacturer in the GDR for one Deutschmark, or shutting it down completely. The owner, which was organized as a cooperative, had different plans. It retooled the Saxon plastics processor as a high-tech company – and is now reaping rich rewards.

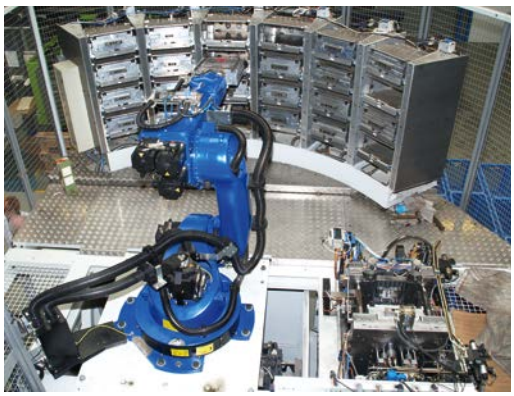
The handles of the brush assortment are produced by the fully automated Z.Shuttle injection molding cell. The innovation is that co-injection, cooling and demolding are performed in parallel processes that are separate in space and time (figure: Bürstenmann)

Anyone who has never wondered what could be special about a brush should take a trip to Stützengrün in Saxony, Germany. Here, in a green spot in the Erz mountains can be found Bürstenmann GmbH, one of the biggest German brush manufacturers. Multicolored conventional and travel toothbrushes, modern 4-component toothbrushes in three bristle thicknesses, children's toothbrushes with LEDs, vibrating toothbrushes, short-head, denture and interdental toothbrushes – even listing the dental hygiene articles is too much – let alone the many different types of brooms, sweeping and scrubbing brushes, wipers and paintbrushes.

The diversity of the assortment, with almost 1,600 articles, is one problem. The other is the high-tech manufacturing technology, which – after reunification – was raised to the state of the art by millions of euros of investment to enable Bürstenmann to make the change from the planned economy of the GDR to the market economy of reunified Germany. The visitor to the factory did not notice that the brush industry was in difficulties in Germany at the turn of the millennium because most of the orders had migrated to China. The crucial role in bringing back the business to Germany was performed by an idea for a fully automated manufacturing system by the machine manufacturer Zahoransky, the guest of Margitta Siegel hears. She has been the sole managing director of Bürstenmann for years. »



The six-axis robot lifts the shuttle mold out of its anchoring in the clamping unit of the injection molding machine from above …



… and places it in one of the compartments of the cooling station. From a different compartment it picks up a cooled mold and transfers it to the demolding station (figures: Doriat)

Currency Reserve for Investment in High-Tech Equipment

From a current point of view, the history of the relationship between the two companies sounds somewhat strange. Bürstenmann – founded in 1924 and part of the group of companies of its shareholder Zentralkonsum eG, Berlin, Germany, which is organized as a cooperative, since 1949 – not only almost completely covered the GDR citizens' need for toothbrushes from the 1950s but additionally exported most of its production not only to socialist sister countries, but also to the Capitalist West. "The company was allowed to keep its earnings from over five-million Deutschmarks of exports as a currency reserve. And repeatedly bought Zahoransky brush machines, which were almost unbeatable at that time," says Siegel.

Now, the Saxony-based company is not infrequently a pilot user for the machine manufacturer and system technology specialist from Breisgau, Germany. The same applies to the computer-controlled shuttle system, which ***Kunststoffe*** reported on exclusively for the first time in 2009. "The teething troubles, particular with the programming and the high maintenance outlay, are long forgotten," says the 64-year-old managing director. The system has run unmanned almost continuously, and as good as fault-free, since 2008.

Why the software is at least as important as the sophisticated hardware becomes most clear to the visitor when, in the production hall, he climbs the steep steps to a platform hovering above the manufacturing cell. Here, you can see how a six-axis robot (Kuka) serves a multicomponent injection molding machine as well as– vis-à-vis the machine – a cooling shelf and a demolding station, alternating with dozens of mold blocks.

The key to all this is a, so to speak, double synchronization: First, the individual phases of a traditional injection molding process can take place in parallel with this arrangement. For the process sequence, this yields, to an approximation, the simple formula "injection time = cycle time." With thick-walled parts, in particular, external cooling and demolding stations shorten the cycle time by up to 75 %. As needed, and depending on the size of the cooling station the system can process different orders simultaneously, with products varying in shape, size and color. In concrete terms, on demand, it produces up to seven different brush bodies in a maximum of four different colors changing from shot to shot – depending on the job list, urgency and "just in time" aspects. For this fully automated continuous process to function, a separate software menu for the process parameters for each product is stored in the Zahoransky-developed control system.

From the Heated Sandwich Manifold Plate via Shut-off Nozzles into a Cold Runner

At the beginning of a cycle, the six-axis robot removes the complete mold block from the injection molding machine – in this case a Systec Multi 200/560-840h/610 (Sumitomo (SHI) Demand) – after injection, and places it in the compartment of a multilevel cooling shelf. Here, the gripper arm picks up a block from a different compartment, in which the moldings have already been cooled, and transfers it to a demolding station developed by Zahoransky. A second robot removes the parts from the mold and places it into the allocated box in a buffer with collecting containers. The central six-axis robot then receives the empty mold, mechanically engages it in the injection molding machine at the stationary mold half and, at the moving mold half, grips the aluminum mold that has just been filled. A new cycle begins. The entire cycle takes about 20 s on average,

The shuttle system permits a seamless change of order from shot to shot

The two managing directors Margitta Siegel (Bürstenmann) and Michael Schmidt (Zahoransky Formenbau). In the background are the receiving boxes of the shuttle cell (figure: Doriat)

and a few seconds longer in the case of thicker-walled parts.

The injection molding machine is equipped with five injection units. Four ancillary units form the basis for ensuring the skin of the brush bodies can be injection molded flexibly in different colors. The main unit prepares the core components. This is a recyclate, usually a polypropylene (PP), containing a chemical blowing agent. The sandwich plate on which the shuttles dock is operated as a hot-runner system. The shuttle tools themselves – as Zahoransky calls the molds apparently gliding through the manufacturing cell – use cold-runner technology.

The two melt streams from the two injection units flow sequentially via shut-off nozzles into a cold manifold. In the co-injection process, the 2-component material combination is then injected into up to four cavities. As it flows into the mold cavity, the swelling flow of the materials is exploited, i.e. the mass flowing in first continually forms a skin layer on the mold wall and thereby encapsulates the second component flowing in. The sprue from the cold runner is mechanically cut off – that permits a color change without purging from cycle to cycle – and is directly returned to the process via the grinder.

Flexible but not fast: in a 3x8-cavity platform mold with transfer technology, straight 3-component handles for toothbrushes are produced (figure: Doriat)

Six-Axis Robot Reads the Microchip in the Mold

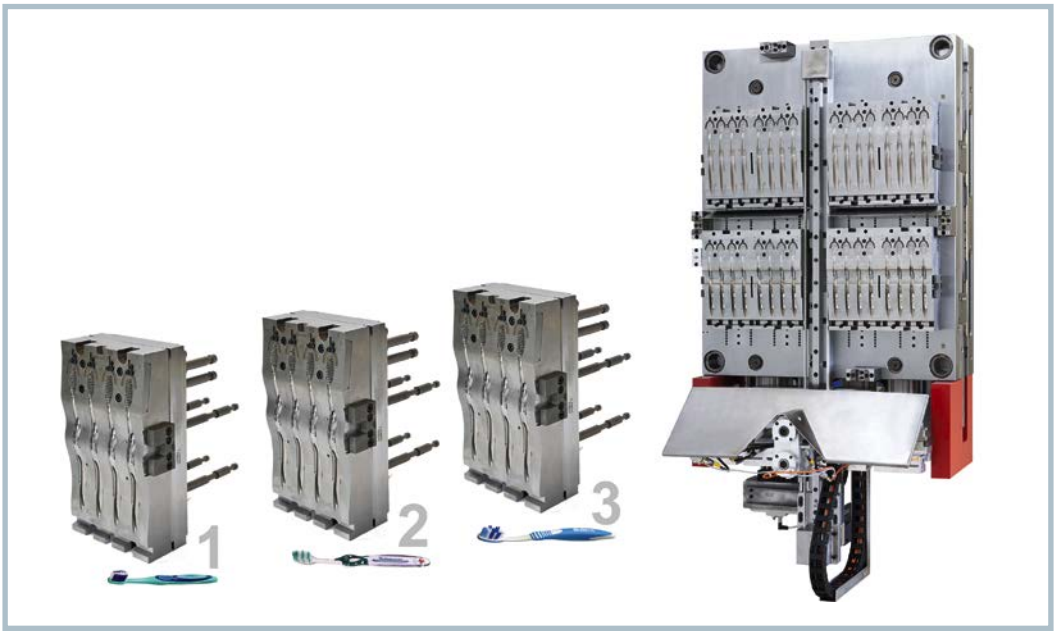
The process reduces the unit costs in many ways, not only because the foaming blowing agent after injection reduces the process time by eliminating the holding pressure phase, and the foam structure developing in the part interior saves material. All the idle times for color or mold exchange, which processors see as a painful fact of life, are eliminated. A microchip is embedded in every shuttle. The six-axis robot reads the chip and reports the formulation required for the next cycle to the injection molding machine so that the production continues without delay with each product exchange. The continual exchange of the removal tools for the different brush bodies is performed fully automatically at a gripper station.

When Bürstenmann includes a new "shuttle-compatible" article in its assortment, it does not take long: "We deliver the complete tested mold with the associated software program within four to six weeks," says Michael Schmidt, managing director of Zahoransky Formenbau GmbH, Freiburg, Germany. Both parties profit from the fact that, over 20 years ago, Zahoransky set up a branch in Rothenkirchen, Germany, not five kilometers away from Stützengrün. The distances for coordination are thus short.

The Evolution of Toothbrush Production

Anyone who wants to purchase a plant should be sure that it has an order situation that is stable in the long term, with a certain product diversity. As is the case with washing brushes, hand sweepers or toilet brushes. "We are talking about an investment of the order of a million euros and a pay-back time of three to four years," calculates Margitta Siegel. The fact that Bürstenmann can produce a few sizes smaller is shown by the walk through the other parts of the original production hall – two new buildings are planned for later. The evolution of toothbrush production over recent years can be seen on this few dozen square meters. And Zahoransky also plays a supporting role here, too.

One-component molds for simple toothbrush bodies are still in use, but in principle are relics »



The modular design of "Platform Line" (in this case 16-cavity for 2-component handles) permits the rapid exchange of all cavity parts. This reduces the costs for retooling for new toothbrush models
(figure: Zahoransky)

of a bygone age. As early as 2003, Bürstenmann commissioned a three-station index plate mold on two-component machines. While the two colored components are injection molded on the first two stations, a handling unit on the cantilever third station removes the end parts during the injection molding process. The mold rotates through 120° between each individual process step.

"The mold is fast, but it is not flexible," explains Michael Schmidt, since, "the gating points must always be at the same places for different models. Tell that to a designer!" Zahoransky launched the alternative design on the market in 2010 under the brand name "Platform Line." "This mold concept is flexible but not fast," says Schmidt. The modular design permits the rapid exchange of all cavity parts, thus reducing the mold costs for new toothbrush models. "Nevertheless, the molds have their price", adds Margitta Siegel, "but they pay for themselves in production, since they function immediately on installation."

The mold inserts of the platform molds are mounted in-place, a frame plate is not used. Exchangeable plates for different handle shapes and head size can be interchanged separately and the cavities displaced in the longitudinal axis to realize different gating points. Thus, for example, children's and adults' toothbrushes can be produced in the same mold. The mold system is subdivided into identical individually centered blocks with four cavities for each block. The individual centering ensures good separation quality, and the mold size can be extended up to 24 cavities in steps of four – "as easy as a Lego kit," says Schmidt, showing the visitor the system in the Bürstenmann production.

In the mold, three injection stations are in stacked arrangement. While an internal handling system simultaneously transfers the 1-component preforms from the lower to the center station and the 2-component preforms from the center to the upper station, an external handling system removes the finished 3-component toothbrushes from above. A Zahoransky SPS that communicates with the injection molding machine via a Euromap interface controls the mold function and the robots.

Company Profile

Founded in 1924 by "Großeinkaufsgesellschaft Deutscher Consumvereine mbH", Bürstenmann GmbH, with about 1,600 articles, now offers a complete assortment of household goods and home-improvement requisites. The company, based in Stützengrün, Saxony, Germany, achieved sales of Ostmarks 100 million with 800 employees before the fall of the Berlin wall, chiefly for the production of brooms, sweeping brushes, paintbrushes and other brushes. Most recently (2013), its 140 employees chalked up sales of EUR 28 million with household goods and toothbrushes.

Since 1990, the wholly owned subsidiary of Zentralkonsum eG, Berlin, has invested about EUR 43 million in new buildings and manufacturing systems and, in 1991, together with M+C Schiffer GmbH, founded the joint venture Denta Bross GmbH & Co. KG (190 employees, sales of EUR 22 million), the number one toothbrush manufacturer in Germany, at its own site. The annual capacity of over 100 million toothbrushes at Denta Bross (the low-level buildings, left, on the aerial photograph) breaks down as about 70 % own brands, including Bürstenmann's own brand Purodent, and about 30 % brand-name toothbrushes.

↘ www.bürstenmann.de

In the platform mold – the transfer handling unit can be seen at the bottom right – the hard component is first placed at the bottom, in the center and at the top, a colored TPE is injection molded. This produces toothbrushes of almost any design (figures: Zahoransky/Bürstenmann)

The Next Step? Flexible and Fast

The next question is obvious: what would be the next step in the evolution? Schmidt's reply comes immediately: "The Z.TIM version of the cube technology patented by Zahoransky – these molds are flexible and fast." The TIM stack mold – the abbreviation stands for total integrated manufacturing – consist of two mold sides with a rotary cube in the center that has two mounting plates at the sides. Following the platform principle, here, too, the mold construction is clearly separated from the cavity component: on model exchange, only the cavity blocks must be exchanged to perform design adaptations at a subsequent time.

The system was actually developed for large-volume applications in the packaging industry and in medical technology, typically for two-part products such as push-pull closures, in which its main advantage comes to the fore: the assembly of the two individual parts outside the mold and therefore also the cycle time. The cube rotates through 90° alternately to the right and to the left. At one side, the hard base body is injection molded and is then overmolded on the other with a (2-component) or two (3-component) colored soft components (TPE). After each injection operation, the moldings are transferred to the assembly units.

Since there is nothing to assemble in the production of toothbrush bodies, the transfer handling unit only removes the parts for interim cooling – though with a clear economic advantage: This step reduces the cycle time. In addition, the cube mold reduces the number of cavities for the same clamping force. While the index and platform molds were formerly restricted to 24+24-cavity systems, Zahoransky has already supplied the TIM mold design as a 48+48-cavity version . However, not to Bürstenmann, but to multinational concerns such as Procter & Gamble or Colgate-Palmolive – the higher purchase price presupposes products with lifecycles of at least five years and very large production rates.

Pros & Cons

At Bürstenmann, the shuttle system with 4-cavity molds supplies twelve thick-walled brush bodies with foamed core per minute.

PROS: What speaks in favor of shuttle technology?

- The external cooling and demolding stations shorten the cycle time by up to 75 %.
- The production cell operates completely autonomously and unmanned.
- Rolling mold exchange permits the synchronous production of different articles in up to four different colors.
- The control process, according to job lists and priorities, permits the flexible processing of production plans, including for low production quantities.

CONS: What speaks against?

- In the basic version, the system costs a six-figure euro sum.
- The high investment requires an order situation that is stable over a long period of time, the process requires a certain diversity of products.

Service

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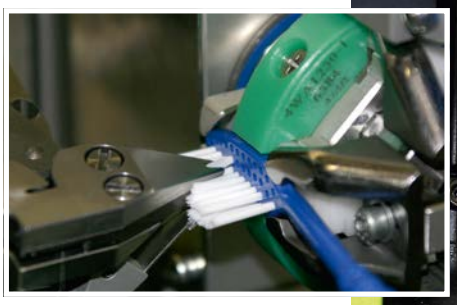
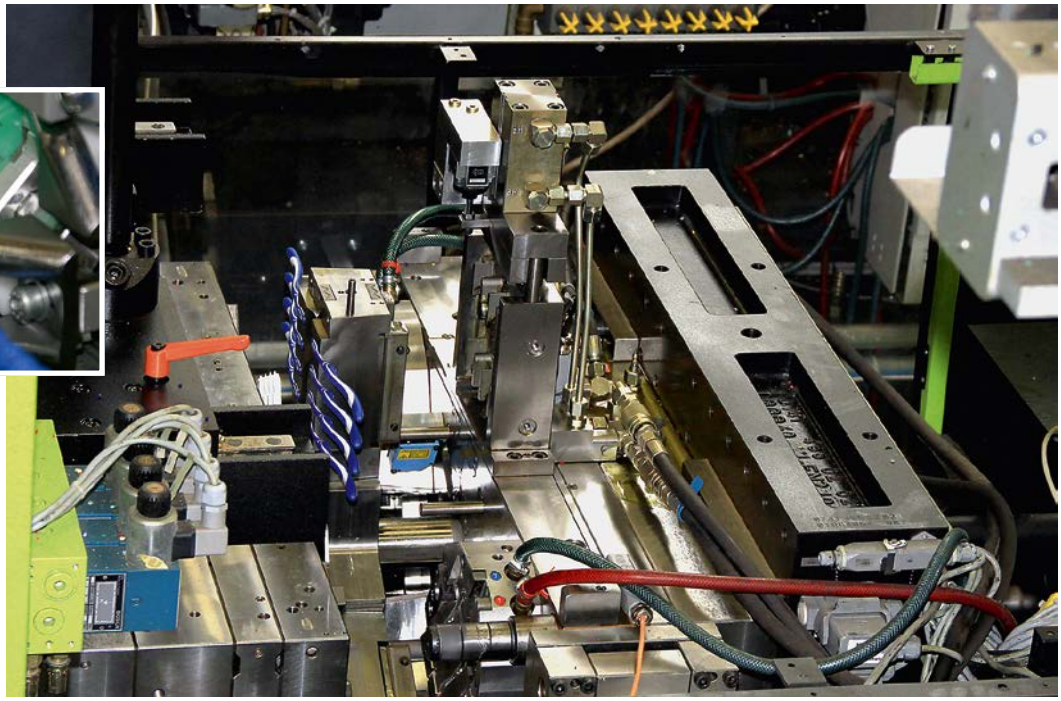
Beyond the Air Shower: A Fully Networked "No Human Touch" Process

Bürstenmann does not play in this league, in terms of quantity at least, though the 110 million toothbrushes per year that are produced in Stützengrün are not chickenfeed. In technical terms, the site can compete with the best in the industry. A key to this is the two new manufacturing halls, for which the company invested over four million euros in 2005 and 2011. They house the production lines of Denta Bross GmbH & Co. KG. The joint venture was founded by Bürstenmann in 1991, together with M+C Schiffer GmbH, which had launched the »





The brush bodies are fitted with bristles at a speed of 1,000 strokes per minute, which is no longer visible to the human eye (figures: Zahoransky/Bürstenmann)

At the end of the fully automated production in interlinked systems, the toothbrushes end up ready for sale in blister packs (figure: Bürstenmann)

"Dr. Best" brand in 1955 and now manufacturers over a million toothbrushes daily at its huge main plant in Neustadt (Wied), Germany.

While Bürstenmann stores the injection molded toothbrush bodies and then fits the bristles, Denta Bross produces finished toothbrushes for well-known brand-name manufacturers with a fully networked "no human touch" process under strictly monitored hygienic conditions. Anyone who wants to accompany Margitta Siegel in the hallowed halls must first put on a protective suit and disinfect their hands before passing through the cleanroom air shower. In the new building, you can see how the toothbrushes are first produced in fully automated interlinked systems and are then packaged in their blister packs ready for sale.

En route from the 5-component injection molding machine (Engel) to the packaging station, the brushes cover a good distance without being touched by even a single staff member. In the bristle machine, the clamped brush bodies are fitted with nylon fiber bundles at rapid speed. The filament bundles are folded in the center and fixed with a so-called "anchor" in the holes of the brush head that are produced during injection molding. In the next station, the nylon bundles are cut to the required length. So that the bristles are not left with sharp edges that could subsequently injure the gums, they are ground and carefully rounded in the last step before packaging.

High-Speed Process

The production lines are trimmed at absolutely high speed with an efficiency of 97%. Bristle fitting takes place at 1,000 strokes per minute, too fast for the human eye even. Since, according to Schmidt, head of mold making, Zahoransky has not found a control system that can manage that, the company came to the rescue with its own development, the Zahoransky Manufacturing Interface (ZMI). So that bristle fitting can really operate at high speed, Denta Bross has sped up the injection molding cycle. Every few seconds, a robot takes a set of brush bodies from the multi-cavity mold and feeds it to the process.

But even that is not the end of the development. As Michael Schmidt explains, a still young process, known as "in-mold tufting," permits the production of anchorless brushes by overmolding the bristle bundle directly in the mold. There will certainly be no less a variety of brush designs with different geometries and color combinations of filament bundles in the future. ■

Clemens Doriat, editorial staff