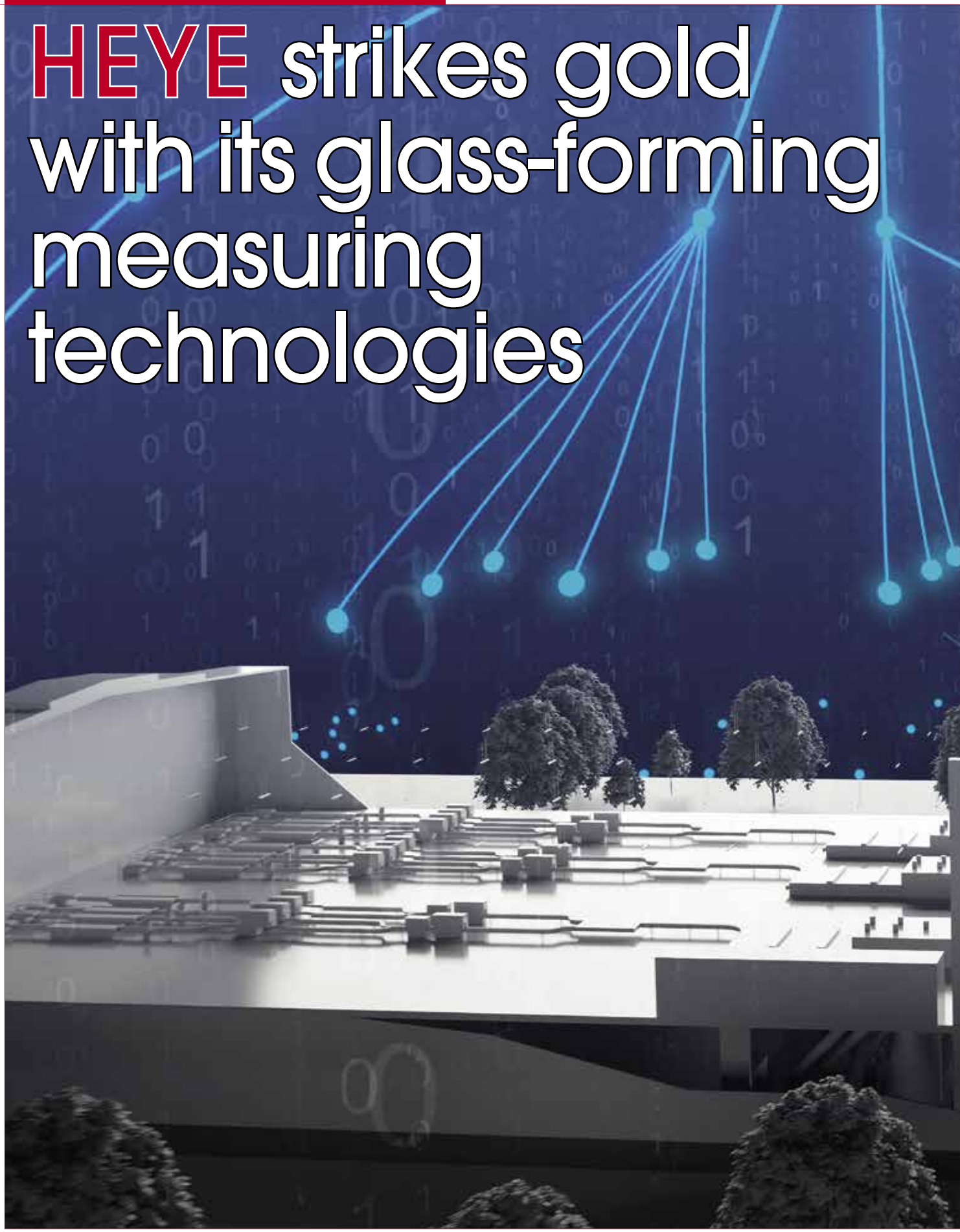
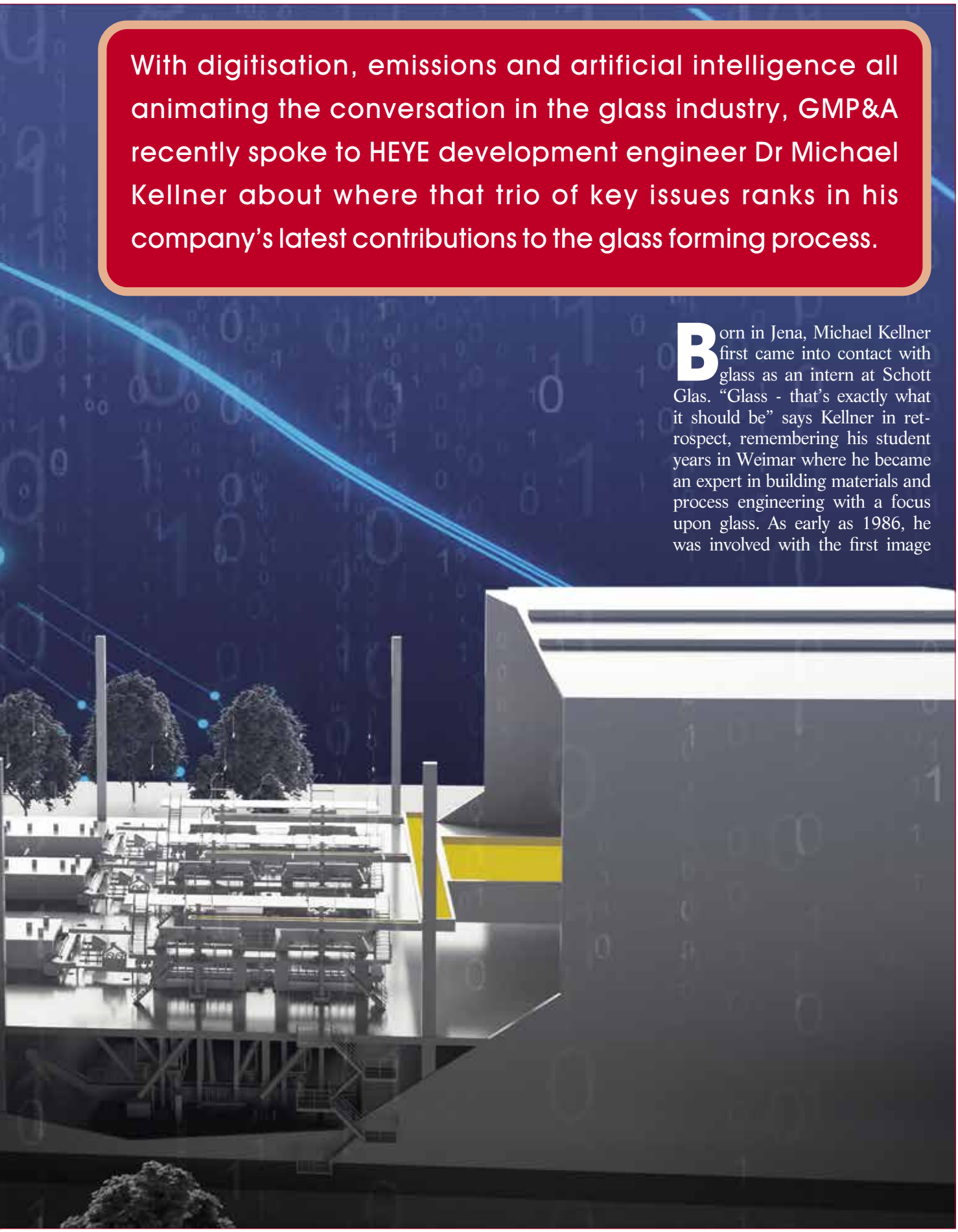
HEYE strikes gold with its glass-forming measuring technologies



With digitisation, emissions and artificial intelligence all animating the conversation in the glass industry, GMP&A recently spoke to HEYE development engineer Dr Michael Kellner about where that trio of key issues ranks in his company's latest contributions to the glass forming process.



Born in Jena, Michael Kellner first came into contact with glass as an intern at Schott Glas. "Glass - that's exactly what it should be" says Kellner in retrospect, remembering his student years in Weimar where he became an expert in building materials and process engineering with a focus upon glass. As early as 1986, he was involved with the first image

processing cameras and their use for inspecting glass. "The theory was there," he recalls, "but the technology was still not powerful enough for the glass industry." While conducting his doctoral research on automation and image processing technology in glass production, Kellner began working at Schott Glas, following which he started as a trainee at erstwhile company Heye-Glas - a very innovative, medium-sized enterprise. Kellner was the initial link between production and development for introducing automation solutions in glass production. In 1992, he was responsible for testing the first image processing applications based on image processors at Heye, and he began developing PC-based image processing solutions shortly afterwards. "Experts at the time thought image processing could never work with a PC," notes Kellner. "A clamorous miscalculation." As a doctoral graduate the 'process engineer' left the company in 2000 only to return to Heye in 2006 as head of development. Since 2019, he has been responsible for the development of digital systems.


Michael Kellner

It's in light of current technological innovations advanced by his department that Glass Machinery Plants & Accessories recently caught up with Kellner in Obernkirchen, Germany, for an update on his company's contributions to measuring the glass-forming process.

GMP&A: Digitisation and Industry 4.0 are both major topics at the moment. How long have you been working on these?

MK: Digitisation is not a new field at Heye. At the beginning of the 1990s, we introduced a PC-parameterizable, electronic timing system for controlling the IS-machines and the Hot End reject system - including the evaluation of pushing glass containers from the dead plate onto the machine conveyor by means of pushers. The complete Hot End process was converted to servo technology - that is, from gob forming to ware handling. This was a huge step into the future, as the motion sequences were now matched and followed by the feedback generators according to the given motion curves. Shortly afterwards, the first servo motors were also used in the IS-machine to make critical process sequences replicable and to avoid container defects. An important component in light glass production is certainly the introduction of the Heye Process Control, which digitally keeps track of the pressing process while also visualising it by recording plunger positions.

In 1998, Heye worked on a Hot End gob camera for recording the cut of gobs. But the resolution of the cameras and the performance of the PCs was not sufficient enough. Nevertheless, the experiences gained were extremely important in order to build up the skills for the following years. When the first grabber cards were available, the new Terra computers were bought and a camera-based mould number reader and a camera-based sealing surface tester were developed.

GMP&A: What's the state of affairs at Heye International?

MK: We've converted complete machine platforms because the market has tended to triple and quadruple gob operation. Consequently, we made all the Hot End equipment 'fit for the future'. Today we offer the complete technology platform for all applications. We are on the right track. The further development of sensors and actuators has created new opportunities. Since the introduction of industry 4.0, we're raising the bar higher and higher. For example, it's we who've developed the new IS-machine - hence the name 'Heye SpeedLine'. The SpeedLine IS-machine is the first machine that is fully bus capable.

The next development goal was to create areas in the IS-machine where sensors, actuators, the necessary cables and the processor technology could all be installed safely and reliably. Safety and reliability, within this context, means protection against heat, oils, oil vapours, water, water vapour, dirt and glass. We've succeeded very well with the SpeedLine because we had conceived the design differently. The cable routing was first designed and then tested where the sensors must be mounted, which includes their protection in technical terms to ensure long-term stability. Operating sensors without failure in a 1.000° C hot environment is not so easy. Thanks to the bus system, all systems in the machine are networked together and a large number of sensors can be managed. This naturally brings with it new possibilities and products, for example the intelligent lubrication interval control - the 'Heye Multi-Circuit Central Lubrication' - which saves oil significantly and increases the lifetime of the components. Also the inline measurement of pressures and temperatures of the equipment should only be mentioned here.

With this machine, we have taken a giant step into digitisation. There is now a 'Communication Tower' that combines all network components, computers and servers in one cabinet. The components are interconnected and communicate with each other. SpeedLine is a platform technology in which components such as robots or measuring and control systems can be integrated very easily. Via the Communication Tower there is also a gateway to the outside, that is to the customer. The Application Programmable Interface 'Heye SmartLink' provides the customer with the data of the manufacturing process for individual data analysis.

GMP&A: Do you do everything yourselves at Heye? For example, programming?

MK: We develop most of the software, especially in the key technical areas. The hollow glass industry is a relatively small and very special market segment. It's difficult to explain the processes to external companies. There are a few components that we purchase, such as sensors. However, the suppliers then work for the glass industry over the long-term and are therefore aware of the requirements.

GMP&A: CO2 emissions reduction will certainly dominate the coming years. What contribution can the container glass industry make?

MK: Indeed you mention what's probably the most topical issue at the moment: CO2 footprint or decarbonisation. If you look at the side of energy consumption and leave compensation models aside, then this is essentially about the sensible use of energy and the avoidance of energy waste.

For us as machine manufacturer, two different directions are relevant when it comes to emissions. On the one hand, it's a matter of minimising losses, which means producing as much as 100 percent of the glass bottles possibly without defects. Then you don't have to throw away glass bottles, you don't waste the energy needed to make them and you have a better CO2 footprint.

On the other hand, the focus is on equipment availability. It's best to operate the machine 24/7 and produce glass bottles without defects. This also includes minimised job change times.

To avoid emissions, it's important that errors be found and eliminated as soon as possible. This is why it's so important to reduce the gap between Cold End information gathering and Hot End information processing. To increase efficiency, we use the 'PlantPilot' information system, which records the efficiency situation and messages deviations to those points that necessitate correction. This results in a significant improvement of equipment availability as well as an increase in yield by reducing transport and quality losses. So efficiency increase and CO2 reduction are always closely related.

GMP&A: By this reasoning, then, the measurements would ideally have to take place at the Hot End?

MK: Precisely! That's not so easy, though, because many of these measurements are contacting measurements. And when I contact a hot bottle with a measuring tool, it gets deformed and becomes unusable. We still lack a solution to how it might work to turn a hot bottle and, for example, to measure wall thickness. That's unrealistic at the moment.

Today, we want to measure the parameters of the forming process directly - keeping them constant within narrow limits. We use infrared cameras at the Hot End to more swiftly identify deviations in the process and, above all, to neither exceed nor fall below the limits - all the while taking immediate countermeasures. This technology is called 'Hot End Closed Loop'. Ideally, non-contact sensors control and regulate the process.

GMP&A: Which control loops do you mean?

MK: Different sensors are also used at different locations for the different process sections. They are then used to influence parameters of the gob, the parison or the bottle. Starting with gob forming, you use a gob camera to adjust and control gob shape and gob weight. Gob temperatures, too, can be measured to influence the spout temperature within the feeder. On the blank side, gob delivery into the blank mould can be detected and adjusted. The tool temperatures on the blank side (blank mould, neck ring and plunger) can also be measured and controlled. Already today, infrared cameras on the machine conveyor are frequently used to measure wall thickness distribution and detect global errors. Optical cameras are planned on the machine conveyor for measuring and controlling the container geometry as well as detecting glass defects.

GMP&A: And at the Cold End?

MK: The manufacturing process is completed when the glass container passes the annealing lehr. The Cold End doesn't deal with controlling the process. Here I should mention the automatic check, using sample containers, to verify whether the inspection machines are correctly set. However such downstream processes as printing or surface treatments for increasing the strength can also be measured and controlled.

GMP&A: What role is played by glass bottle weight and shape?

MK: In the 1990s, a price war broke out for disposable packaging. In order to save on raw material, energy and transport costs -but also to reduce the charges to the dual system for disposable bulk items- projects have been launched to reduce the weight of glass containers. That means producing with thinner wall thickness. Heye has a very big advantage with its experience from H1-2 technology. As such it was

Smartline2 Cold end inspection machine

able to transfer this to IS-machine technology. A relic of these times is the famous Paderborner beer bottle. Here it was revealed that shape has an immense influence on container weight - all the while maintaining its strength. Today we seek a compromise between individual bottle shape, volume and weight with sufficient strength. If we wish to become more ecological then we'll have to compromise on individual bottle shape in favour of container weight.

Many machine components and HI products, which were already developed for light glass technology at the time, are now standard in industry. Starting with the 'Process Control', through axial cooling and hot end transport – all components that can be put to use with our lightweight container production know-how.

GMP&A: It seems lightweight glass production is a great challenge.

MK: A key characteristic of simple light glass is that it breaks very quickly - a problem you can address with thermal or chemical post-processing, only it will increase unit costs. No one is likely to pay a deposit of several Euros for a gorilla milk glass bottle. Here a technology needs to be developed going forward that's based on current hollow glass production while being efficient. Looking ahead, anyone in lightweight glass production who manages to increase and maintain glass surface strength will be at the forefront of history.

GMP&A: Where do you see further emission savings potential?

MK: I see big emission savings in the global glass industry in the area of recycling cullet from the market (waste glass collection and processing), because much less energy is needed for glass bottle production from cullet than for production from raw materials. Energy savings through heat recovery from the forming processes and in the annealing lehr have further potential. Here the ecological approach follows the economic approach: If you save energy, you also save money. That alone marks a strong incentive. The biggest cost factor in glass production is energy.

GMP&A: Heye machines are in use worldwide. Remote access and remote maintenance are becoming ever more important. What needs to be taken into account here?

MK: Security considerations are essential for remote access via the Internet. Cyber criminals are lurking everywhere, and so companies are sealing themselves off more and more. This means service providers get blocked from entering company networks to connect to the machine and provide support from there without considerable effort. Solutions must be found in consultation with customer IT departments.

GMP&A: How do you assess the potential of artificial intelligence for the glass industry?

MK: AI is currently high on the agenda. At the moment I'm in the third wave, the first having been in the 1980s and the second in the 1990s. You can certainly do a lot with artificial intelligence. But you must bear the boundaries in mind. Artificial intelligence is determined by information gleaned from the past. In order to learn a corresponding neural network a large number of objects are needed, both good and bad, as examples. Here we talk about 500 to 5.000 pieces of information. Gaining and learning these examples requires much effort. The neural network can't begin with new objects that keep appearing. There are AI applications, the decision is already working very well. In the glass industry, on the other hand, this only works for simple applications, such as reading mould numbers in the seven-segment code. Glass defects, on the other hand, become more difficult because they always look different. If new information is added that the trained system doesn't know, AI will not get any further. Basically, no two checks are exactly the same. Perhaps a combination of imaging processes and neural networks can help, but that's still a dream for the future. ■

ABOUT HEYE INTERNATIONAL

Based at Obernkirchen, Germany, Heye International GmbH is one of the international glass container industry's foremost suppliers of production technology, high performance equipment and production know-how. Its mechanical engineering has set industry standards for more than five decades. Extensive industry expertise, combined with the positive attitude and enthusiasm of Heye International employees is mirrored by the company motto 'We are Glass People'. Its three sub-brands HiPERFORM, HiSHIELD and HiTRUST form the Heye Smart Plant portfolio, addressing the glass industry's hot-end, cold-end and service requirements respectively.

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