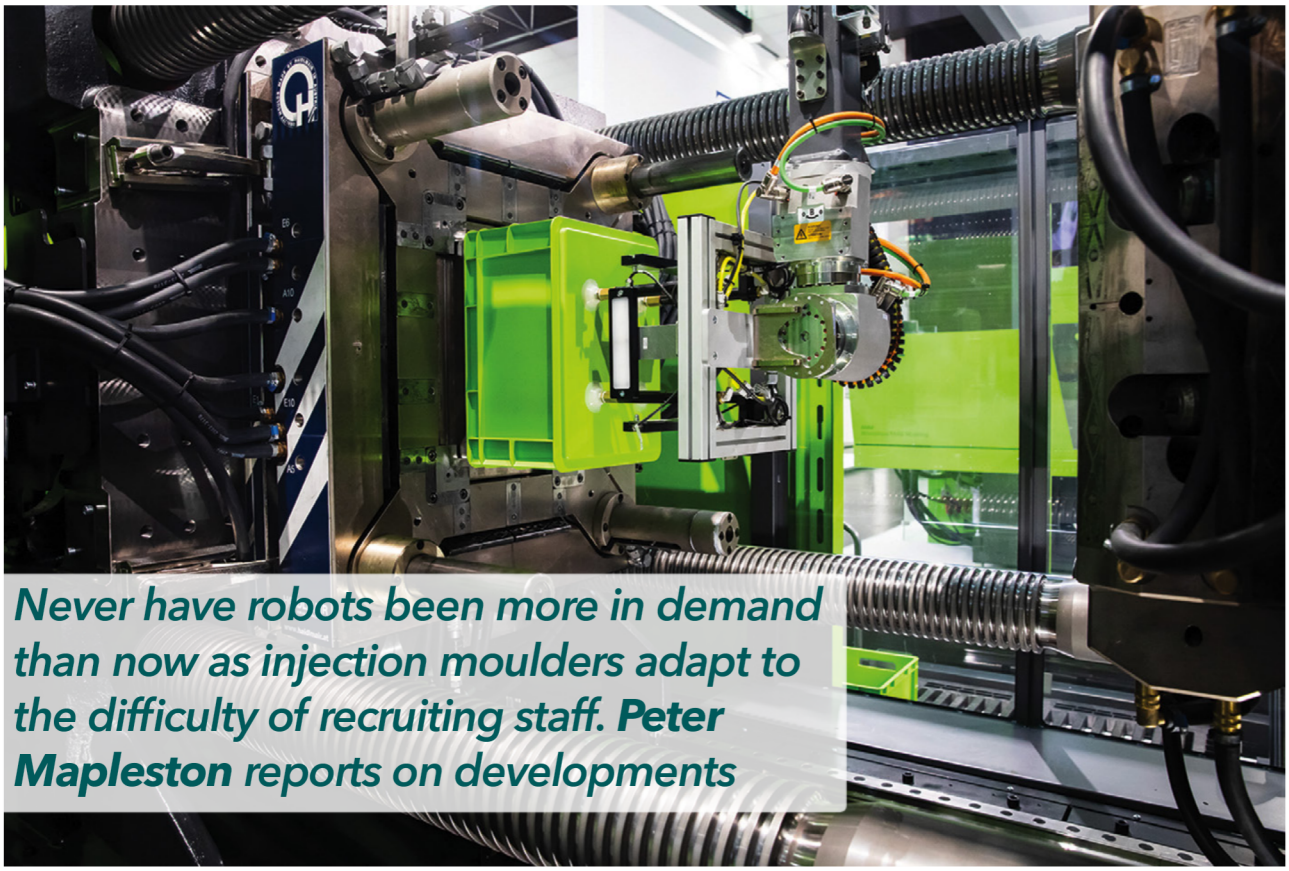


IMAGE: ENGEL

Never have robots been more in demand than now as injection moulders adapt to the difficulty of recruiting staff. Peter Mapleston reports on developments

In search of lost time: Robots help cut cycle times

Automation systems involving various types of robots are helping injection moulding companies produce better parts, faster. They are also helping them recover from reductions in the workforce caused by long- and short-term factors: getting people to do mundane jobs has never been easy and it is getting harder; plus, Covid-19 continues to cast its shadow over operations in closed environments.

Andreas Armbruster, Head of Automation & Turnkey Solutions at Arburg, says: "The level of automation in plastics processing is continuously increasing. Arburg currently supplies around one in three injection moulding machines worldwide together with a robotic system. Not only is the complexity of the systems increasing, but very flexible automation solutions are also in demand. The range of automation solutions extends from simple sprue pickers and linear robotic systems to six-axis robots and complex turnkey systems."

He continues: "Robotic systems are particularly helpful in the production of medical equipment during pandemics. The increased demand for cleanroom production that has been observed for several years has once again gained significant momentum as a result of the current situation."

Arburg six-axis robots have the same user interface as the Allrounder machine controller. As the Gestica control system is gradually replacing the proven Selogica, all six-axis robots made for Arburg by Kuka have been equipped with the new Gestica user interface as standard since the start of the year. This ensures even better performance: with the new sequence editor, robot programs can be created much more quickly than before.

(Arburg customers can decide which robot system they prefer; however, Kuka is the only six-axis robot solution with the Gestica user interface, which means that its sequence can easily be defined ty the machine operator, with no need for special programming knowledge and

Main image: If the robot can travel into the mould area during the mould opening movement, cycle time can be shortened. The effect is particularly large in the case of parts with long cores, such as boxes, shown in this photo from Engel

Right: Arburg six-axis robots have the same user interface as the All-rounder machine controller – since the start of the year, the Gestica user interface has been standard

(expensive) external robot experts.)

Arburg also offers an optional feature, Dynamic speed control, with which speeds and acceleration of the servo axes in linear Multilift robotic systems can be automatically adapted to the injection moulding cycle outside the mould. The robotic system is ready about one second before the mould-entry operation but does not move any faster or more dynamically than necessary. This significantly reduces wear and energy requirements.

Artificial intelligence (AI) is becoming increasingly important in mechanical engineering, not least because of the need to automate injection moulding processes efficiently and flexibly despite ever smaller batch sizes and shorter product life cycles, says Armbruster. "A useful application example of AI is the automatic programming of robotic systems. The idea is that the operator simply enters the starting point and destination, as with a car navigation device, and the system automatically calculates the optimal route."

Engel showed its expanded range of smart assistance systems at the Fakuma 2021 show in Germany last October. The new iQ motion control enables Engel Viper series linear robots to make a safe early start combined with fully automatically optimised track planning.

When movements of injection moulding machine and robot are coordinated, cycle times can often be reduced. This is because the robot arm can start moving into the mould area before the mould is completely open. Nothing new here in principle, but the implementation of the concept is becoming more sophisticated.

Individual movement points as well as the speed and acceleration of the entry movement are specified during the teach-in. Whereas in the past, the trajectory of the robot was determined manually, the new iQ motion control reduces this

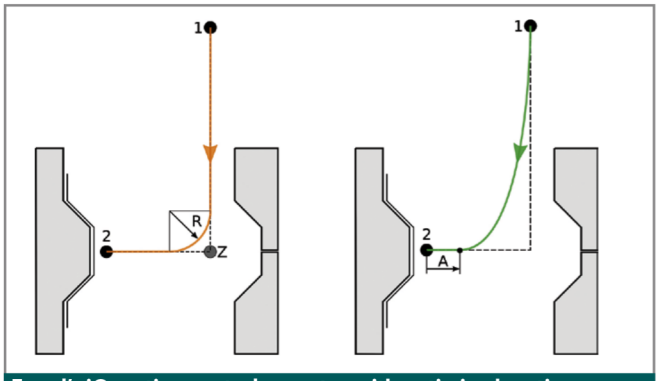
IMAGE: ARBURG

teach-in to a few clicks, with software doing all the hard work. IQ motion control is now included as a standard feature on all new linear robots in the Engel Viper series.

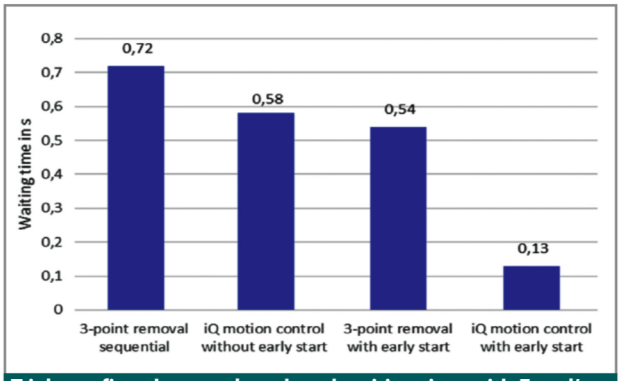
Engel says the efficiency gains are particularly clear in applications with large mould opening strokes, such as the production of deep housing components, boxes or containers, which require long mould cores.

To exploit the potential, Engel has performed tests with a Viper 12 linear robot. With a mould-opening stroke of 490mm and a maximum velocity of the movable mould mounting plate of 1,465 mm/s, an overall cycle time of 15 s was achieved. The robot early start was at mould position 303 mm. A greatly shortened waiting time was found (see bar chart). Waiting time is defined as the time that elapses between the completion of the mould motion and the end of the phase during which the gripper enters into the mould space.

With an overall cycle time of 15 s, for an as-



Engel's iQ motion control operates with optimised motion planning (right). The path is computed as a whole and not generated by approximate positioning of single-axis movements
Source: Engel



Trials confirm the greatly reduced waiting time with Engel's iQ motion control and early start
Source: Engel

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sumed continuous operation of 24 h, with iQ motion control and with early start, 236 more parts per cavity can be produced per day than with sequential three-point removal.

In January, **KraussMaffei Automation** launched a similar function called "synchronous motion." Again, component demoulding and the opening movement of the machine are synchronised. "Sometimes, this also makes it possible to do away with expensive gripper hardware," says the company. "The ejector movement is often used for difficult-to-demould parts. The robot grips the finished part during the demoulding process and the ejector pushes the component onto the gripper. This requires a costly pneumatic system at the handling. However, if the gripper moves along with the ejector, no pneumatic system is required."

The synchronous motion enables the demoulding time to be reduced by approximately 35%, according to KruassMaffei. In the production of refuse containers, for example, this means a 6% reduction in the complete cycle time; for crates, it can be up to 4%.

KraussMaffei offers synchronous motion both for new machines and in the form of an update for the MC6 machine control system for existing machines and complete systems. It can be applied to LRX linear robots and IR industrial robots.

Sumitomo (SHI) Demag has launched its own range of cartesian robots engineered in-house. The SAM-C (SAM denoting: Sumitomo. Automation. Machine) series is claimed to deliver the smallest injection moulding footprint comprising robot and material handling technology. The company says it has intentionally focused its efforts on developing scalable units with more automation functional elements. The "handle & place" robots are already available in four payload sizes – 3, 5, 10 and 20 kg – for injection moulding machines with clamping force sizes between 500 and 5,000 kN, and for standard applications with cycle times of 10 s and higher. Further robot kinematics and functional elements will roll out in the next couple of years.

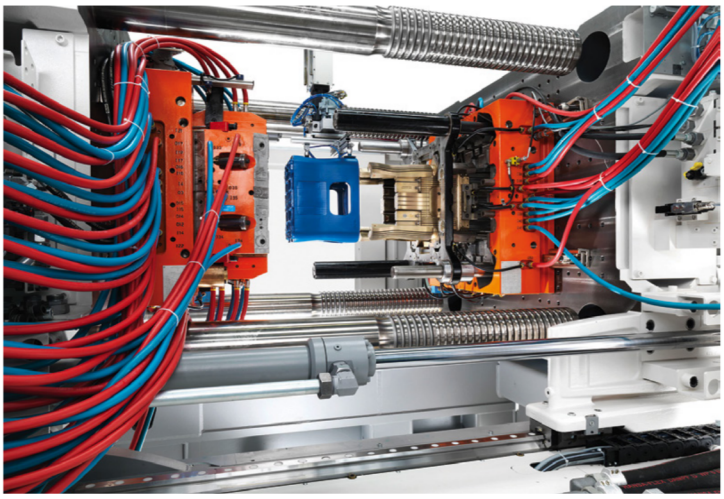

IMAGE: KRAUSSMAFFEI

Above: With the synchronous motion function from KraussMaffei, the gripper of the robot starts faster, saving cycle time

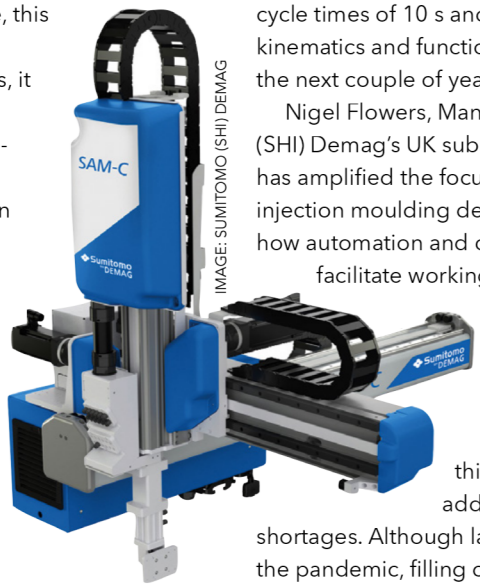

IMAGE: SUMITOMO (SHI) DEMAG

Left: Sumitomo (SHI) Demag's new SAM-C robots are available in 3, 5, 10 and 20 kg payload sizes

Nigel Flowers, Managing Director at Sumitomo (SHI) Demag's UK subsidiary, says: "The pandemic has amplified the focus on productivity and forced injection moulding decision makers to reconsider how automation and digitalised technologies can facilitate working smarter. Scalable, flexible units are in greatest demand. That's why the group launched the SAM-C series at Fakuma last year."

He says: "Automation like this can help customers to address the acute staffing shortages. Although labour was a challenge before the pandemic, filling certain jobs is becoming ever more challenging. Jobs being vacated by the baby boomers (which accounts for over 25% of the workforce in some territories) are not attracting the Millennials and Gen Z's, which is another pressure on top of escalating material prices and supply chain issues." ›

Factory robot density is accelerating

According to the **International Federation of Robotics** in its 2021 World Robot Report, the use of industrial robots in factories around the world is accelerating at a high rate: 126 robots per 10,000 employees is the new average of global robot density in the manufacturing industries – nearly double the number five years ago. The average robot density in Asia/Australia is 134 units, in Europe 123 units and in the Americas 111 units.

Europe´s most automated country is Germany; 38% of Europe's operational stock is in that country. The UK has a robot density below the world average of 126 units with 101 units, ranking 24th. The exodus of foreign labour after Brexit increased the demand for robots in 2020. This situation is expected to prevail in near future.

Cobots expand

In March, **Fanuc**, one of the world's biggest suppliers of robotics, extended its range of CRX collaborative robots (cobots) with the CRX-5iA, CRX-20iA/L and CRX-25iA units. It says it now offers the most extensive line-up of easy-to-use cobots available on the market today. The numbers indicate maximum payload. Fanuc offers cobots as a safe, easy-to-use, reliable and a versatile solution for a wide range of applications. No maintenance should be required for up to eight years.

Ralf Völlinger, Vice President, General Manager, Robot Business Division, Fanuc Europe, says: "Equipped with intelligent features such as vision and force sensors, the flexibility of cobots means they can perform tasks like palletising, parts handling, assembly, bin picking and arc welding."

Italian ski goggle producer LEM makes use of cobots from **Universal Robots** in three separate processes in its operations. One works with a laser that marks the lenses in an operation that requires very precise positioning (there are actually two identical cells). "We wouldn't have been able to do this without the cobots," says Stefano Lodigiani, general manager and co-owner of LEM. "Manually, it is simply impossible to keep a constant distance from the laser focal point, whereas the cobots guarantee the precision and repeatability we need to perform the process impeccably."

In the second process, a cobot applies adhesive to the foam cushioning that is later fitted to the goggle frame. The operation is carried out on a mezzanine floor, so the low weight of the cobot was an extra advantage.

In the third process, a cobot works very closely with operatives on injection moulding of the frames. The process is unusual in that the parts are removed from the machine together with the mould insert. The operative separates part from the insert away from the machine. Lodigiani says: "The cobot improves the ergonomics of the moulding station (the inserts weigh about 1 kg each, so the operator is required to handle about 4 kg of material every 60/70 seconds) and optimises the rate of production. The cobot ensures that the application proceeds at a constant rate and pressure."

Below: Workers at LEM in Italy working with cobots from Universal Robots

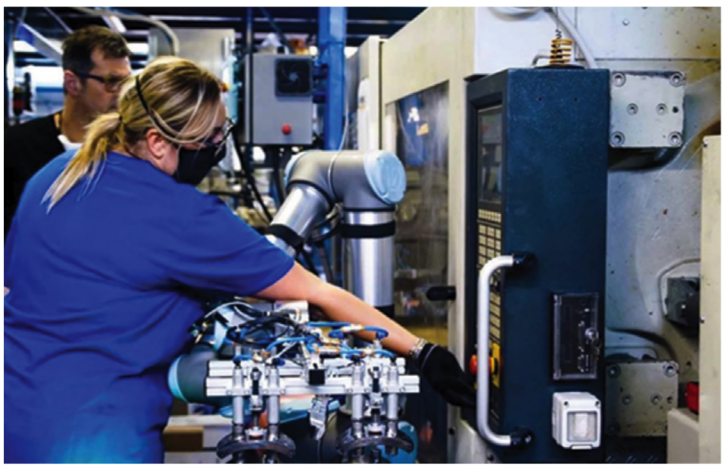

IMAGE: UNIVERSAL ROBOTS

Right: Fanuc CRX cobots

IMAGE: FANUC

In February, **Muller Technology**, which specialises in automation solutions for thin-wall packaging, launched an automated six-axis case packer for high-volume production of lid and container packaging. According to Taras Konowal, Muller's Director of Sales and Marketing for North America, Muller developed the new system after customers, mostly in North America, called for a solution to ongoing problems in finding staff to pack containers and lids manually. Konowal says interest is now picking up in Europe too, mostly in Germany, for the same reason. First installations are currently being implemented.

"Applications are mostly for high volume operations, where you would normally employ at least two people to fill boxes," says Konowal. "With this solution, you can have one person dedicated to several machines, making and closing the boxes."

Konowal says the six-axis case packer delivers greater productivity than a cobot case packer launched last year (see *Injection World* April 2021). "We have found that cobots have more limitations than we expected for this application. They are inherently not as fast as regular robots, and if operatives come into range, not always intentionally, they go into collaborative mode, which is even slower. Employees need to get used to working with cobots, and that is not always easy. The six-axis robot on the other hand is completely guarded. It is one of our most productive systems for high-volume packaging lines." It can handle up to 64 cavities every 6 s for lids and 5 s cycles for containers.

The new case packer can be purchased sepa-

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rately or integrated into automation systems, including IML systems, in which Muller also specialises. The product platform will be manufactured in Switzerland and Colorado.

Growth in IML

IML started in Europe long before it took off in North America. Recently though, Konowal says, business has been slowing down in Europe, partly due to a fall in new product introductions. In North America, business dropped off when Covid-19 took hold – "Businesses just wanted to get stuff on shelves," he says – but in recent months it has dramatically increased. "Orders are now double what they were in the middle of the pandemic. Lots of round containers are now being converted to IML from shrink labels, driven by sustainability issues. With IML, the container and the label are the same polymer – usually PP or PE – so they are easier to recycle than products with shrink labels that are typically in polystyrene."

VistaTek, a custom injection moulder based in Stillwater, Minnesota, is one processor using IML technology from Muller to make mono-material containers, but the material in question is PLA, and the containers are compostable plant pots.

The 100-mm round pots are said to be among the first to contain plant nutrients which are compounded into the plastic resin formulation. The plant is put in the earth still in the pot, which then degrades in a few weeks. The nutrients which are compounded into the plastic break down and feed the plant, thus enhancing the overall growth potential.

VistaTek developed its first garden pot in 2014 and it has since evolved with different materials and now an added label decoration. The company developed a special PLA formulation and a patented four-tab construction.

Innovation in the Muller IML system takes care of the unusual design of the VistaTek pots, which have vent holes to allow for passage of water when the pots are planted in the earth. "The label has to go around the holes, there is no room for error," says Konowal. "The trick has to do with the dummy cores, and how the IML system works with the mould to signal that the label is in position."

IMAGE: VISTATEK

Left: Biodegradable plant pots from VistaTek are 100% PLA, including the IML label

IMAGE: CAMPETELLA

Above: Campetella's Modula W high-speed side entry robot for stack moulding has carbon fibre reinforced composite arms that show minimal vibration while guaranteeing very precise label positioning. It will be on display in a fully automated system for IML production at K 2022

Star Automation Europe is another player with extensive experience in IML automation systems. "In particular, we have developed great experience in IML automation systems dedicated to fruit and vegetable crates, in particular for IMMs with a clamping force ranging from 6,500 to 10,000 kN, in order to improve the impression of the crate quality and to enhance the perception of the content itself," says Sebastiano Deppieri, Marketing & Branding Manager.

"With a dry cycle time lasting less than two seconds, a Cartesian robot ensures a faster actioning time in comparison with a six-axes robot, and this is something that must be absolutely kept in mind when a swift and continuous production is required. Moreover, a Cartesian robot saves a good deal of space."

Star Automation EOATs for labels are slightly unusual in that the labels are not electrostatically charged by metal tips but by a special bicomponent resin, which evenly shares electrostatic charge on the entire surface. This is said to reduce the weight of each EOAT for labels by 15%. Any risk of electrostatic charge between the EOAT and the cavities of the mould is also eliminated.

Italian robot maker **Campetella Robotic Center** says the Covid 19 pandemic sparked an "explosive" growth in medical and packaging industries, while the automotive industry's growth was prompted by investments in electric cars.

"Being outstanding at providing All-In-One

IMAGE: WALDORF TECHNIK

Above: Modular automation system by Waldorf Technik based on Vario TIP platform

standardised automation solutions, Campetella has benefited even more from this growth," says Marketing Manager Gaia Campetella. "Large companies have been struggling to find and keep operators to perform repetitive tasks, such as packaging finished products. Campetella provided them with a complete range of standard robots to be integrated within downstream automation solutions."

Campetella has turned to 3D printing technology to produce hundreds of components overnight in a much cleaner and faster process than traditional CNC production. "Moreover, such parts are much lighter than metal equivalents, enabling robots to work faster and without vibrations," Campetella says. "Wherever possible, our engineers are also replacing pneumatic actuators with electric servomotors in order to reduce CO_2 emissions while increasing reliability and efficiency."

Waldorf Technik is specialised in the high-speed automation of injection moulding processes in the field of medical technology. It has developed a new modular automation system that it says helps manufacturers of diagnostic consumables such as pipette tips to significantly reduce time to market. "With the global pandemic we all learned that time is even more crucial than before," says Martin Maier, Head of Sales. "Thanks to the introduction of standardised designs based on the modular automation system, Waldorf Technik was not only able to significantly reduce the entire project development but also reduce the effort for the qualification and commissioning of the systems."

The system is composed of modules for each individual step, such as removal, filter assembly, visual inspection, as well as exchange or refill modules and various packaging modules.

Depending on customer requirements, Waldorf's Vario TIP FSS (Floor Space Saving) module for cavity-sorted filling of a workpiece carrier can be used. This carrier is used to transport, for example, a packaging unit (rack) through all process modules and ensures high precision in the modules as well as 100% cavity traceability. The parts are not put into the final packaging until all process steps have been completed. This allows the concept to be easily adapted to different packaging variants and requirements.

Waldorf says the modular approach has enabled it not only to significantly rationalise project development but also reduce the effort for the qualification and commissioning of the systems.

At **Sepro**, one of the biggest suppliers of robotics for injection moulding, Raul Scheller, Managing Director, North America, says: "It is probably not surprising, but medical is the obvious market where we have seen a significant increase in the past 18 months. Fortunately we also have seen increases across the board in almost every market. Due to the continued strong demand from consumers, as well as the labour shortages, our customers continue to move and add automation in their sites. Robots and automation give them an opportunity to further optimise and increase output, and to have full control over their operation. Also, we are seeing customers purchasing robots and/or automation for the first time, many of whom would never have considered it a few years back. They have made this decision in order to stay competitive, and they have seen a good return on their investment. Plus, it provides them with full control of their operation."

The value of robots in a complex injection moulding job is illustrated by automotive supplier **KE Elektronik** (part of connector company Amphenol) headquartered in Kressberg-Marktlustenau, Germany, which produces engine fan connectors by overmoulding four metal contacts with three different plastics. Production is complex and involves numerous testing stages as well as complete traceability. With demand continuing to increase and skilled workers hard to find, the company needed a new intelligent automation solution.

It chose **EGS Automation** to create an automated manufacturing island interlinking two punching and bending units and two Arburg injection moulding machines with an output of several million connectors per year, running at cycle times of under 10 s. The result, which fits into a space 15 x 6 m, includes six Motoman robots by **Yaskawa**, a lot of handling and testing technology, and a palletising system. The plant has been running in three shifts since September 2021.

The complete line is divided into four modules. In the first, two punch-bend units ensure continuous provision of signal and power pins. Each unit

has a Motoman GP7 with mechanical gripper equipped with integrated sensor technology.

The contacts are positioned in workpiece carriers, which are then passed to a Motoman GP50 on Module II. This 6-axis robot, with a reach of 2 m and a maximum payload of 50 kg, fits the carriers into a two-component injection moulding machine that first fixes the contacts in position, and then overmoulds a connector plug.

Finally, the overmoulded connectors are placed on another workpiece carrier, which is transferred to Module III. Here, another Arburg machine overmoulds a liquid silicone rubber lip onto the connectors. This obviates the need for a separate seal. Module III also uses a Motoman GP50. It removes the connectors from the workpiece carrier and checks to make sure they are at the right temperature before overmoulding, by holding them in front of a thermal imaging camera.

Another Motoman GP7 is used on Module IV, where the task is to pick up the finished parts and move them to a revolving transfer unit. "On this revolving transfer unit there are various test stations and an assembly station equipped with a Motoman SG650 SCARA robot. We've succeeded in integrating a really large number of processes in an extremely compact space," says Jens Gradenegger, Team Leader Injection Moulding Automation at KE Elektronik.

Early in the Covid-19 pandemic, **Stäubli** collaborated with companies in the Auvergne-Rhone-Alpes region of France in a high-speed project to create an automated production cell for medical ventilator filters. The cell, which combines Stäubli's TS2-60 SCARA robot and TX2-90 6-axis robots, was designed and manufactured in under ten weeks.

Infiplast, which specialises in medical devices, was charged with the design, prototyping, testing and manufacture of a new housing containing the heat and moisture exchanger (HME) filter. The cell takes up only 8 m² of space.

The TX2-90 robot collects the various plastic parts for the filter from the press outlet. It places the base of the case and its cover on a turntable. After inserting the foam and the membrane, the six-axis robot assembles the box and places it on the ultrasonic welding station.

The TS2 SCARA robot then positions the boxes for final operations: testing and labelling. It directs the compliant filters toward packaging, and channels non-compliant filters to the rejects. A quality assurance system is integrated into automated production.

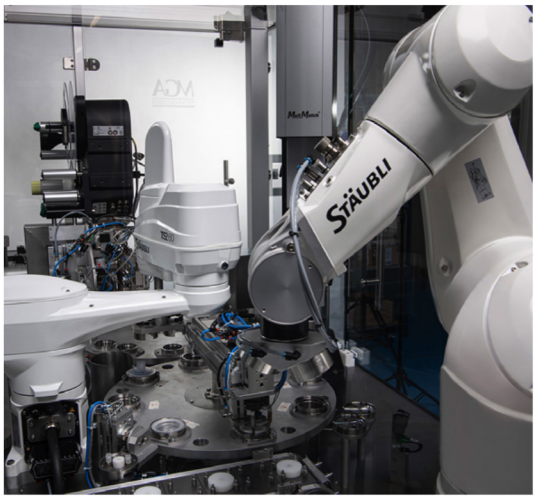

IMAGE: STÄUBLI

Left: During filter production at Infiplast, the two robots, a Stäubli SCARA TS2-60 and a six-axis TX2-90, work hand in hand

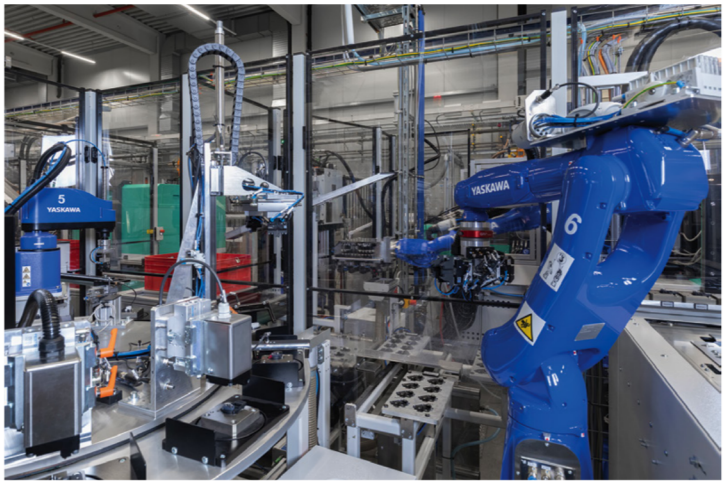

IMAGE: KE ELEKTRONIK

Above: The Yaskawa Motoman GP7 robot at KE Elektronik is critical in terms of the time cycle because it not only loads the rotating transfer unit but also finalises the process by placing the finished parts in trays in an automated palletising system

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