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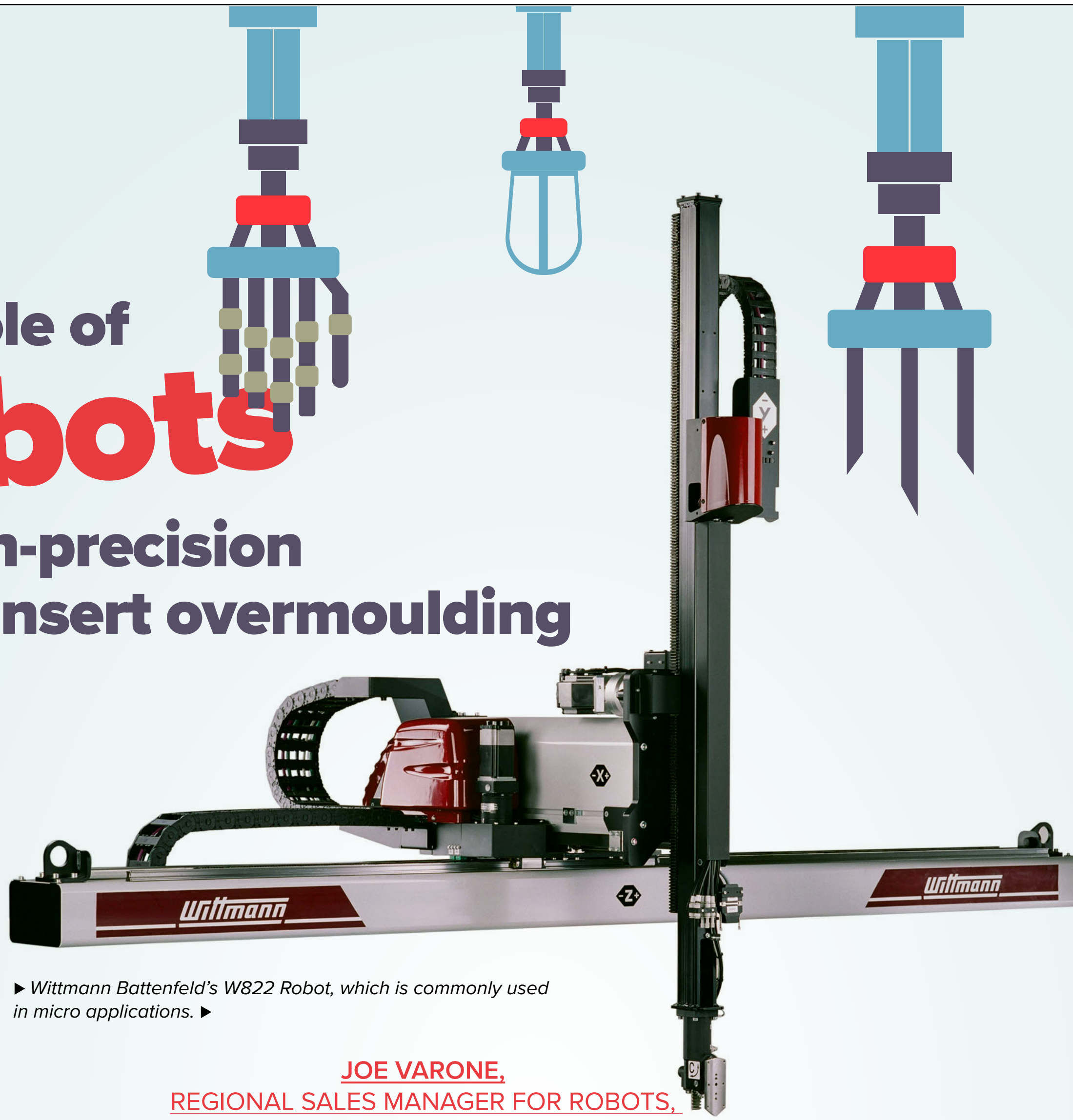


The role of robots in high-precision microinsert overmoulding

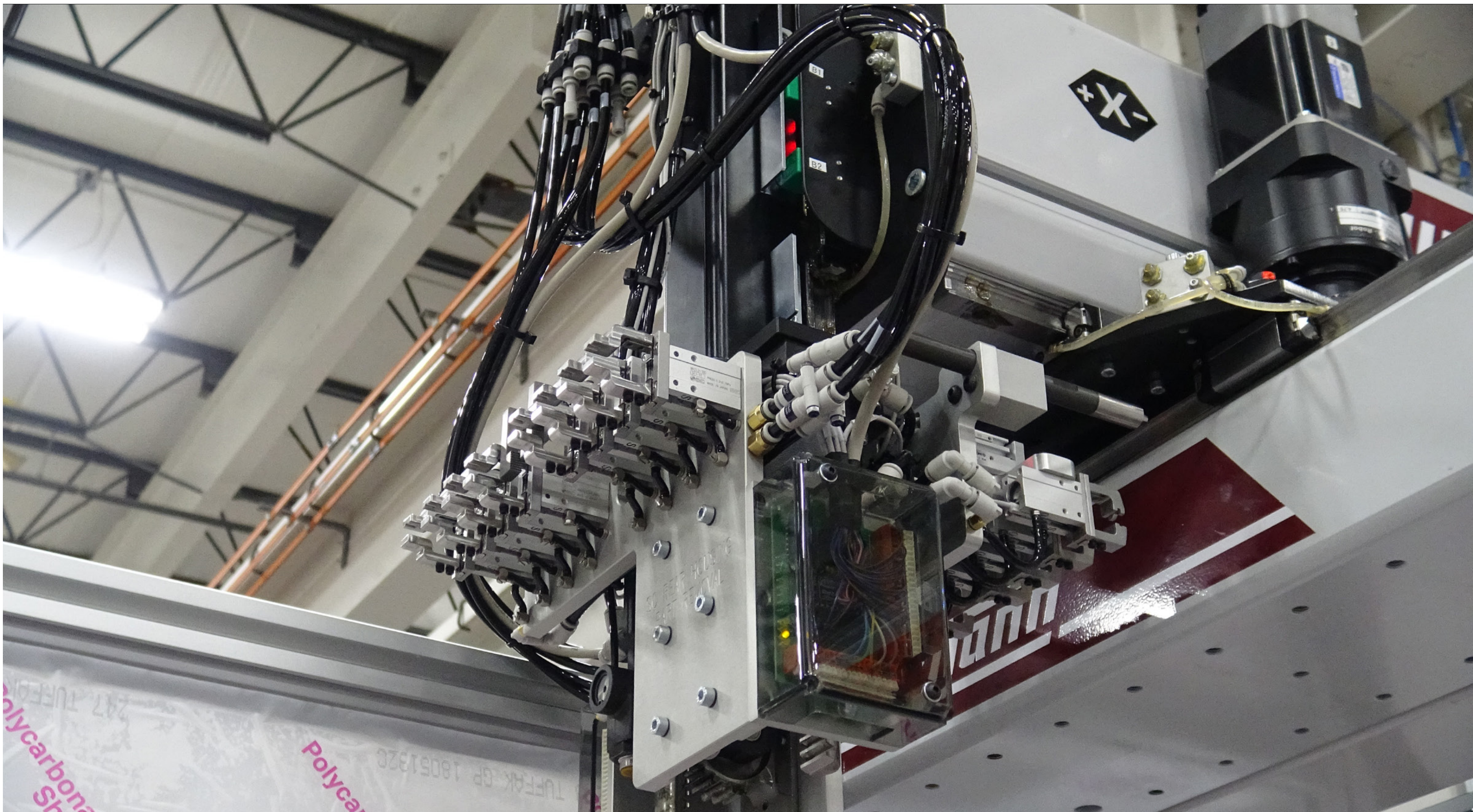
▶ *Wittmann Battenfeld's W822 Robot, which is commonly used in micro applications.* ▶

JOE VARONE,
REGIONAL SALES MANAGER FOR ROBOTS,
WITTMANN BATTENFELD

Insert overmoulding has been around for years but early on it was rarely handled by a robot. The robot technology for insert overmoulding applications back then was premature and not very capable. They were, and sometimes still are, handled manually by the workcell operators, especially in the case of challenging inserts. For years, horizontal moulding machine press-side operators would wait for the mould to fully open, let the parts fall, swing open the operator side gate and carefully orientate and hand load the inserts into the mould cavity, then close the gate to allow the overmoulding cycle to continue. This direct, labour-intensive process was inefficient and potentially insert miss-orientation prone. Vertical moulding machines had similar challenges, but because the top-entry robot design favours horizontal machines, vertical machines did not experience the benefit of top-entry robot technological advances.

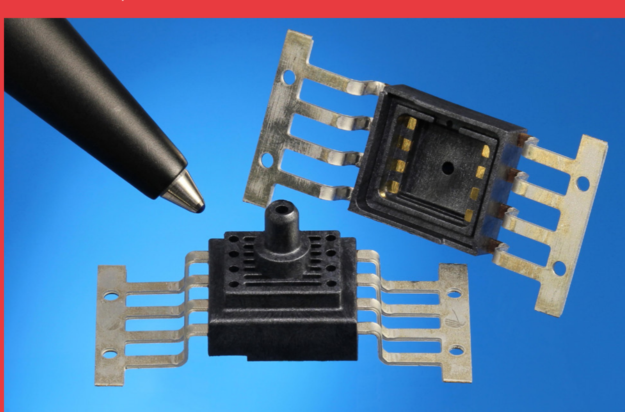
There are many insert pre-mould materials; metal and plastic are among the most common and traditionally used, then there is the increasing number of exotic ones being explored for electronic and medical parts. Typical pre-mould inserts range from a common threaded metal bushing to a plastic pre-mould, the handling of which does not depend on the use of eyeglasses or scopes.

Over the years, technology has improved, particularly with horizontal moulding machines and top-entry linear robots, and now most moulders with higher production runs for overmoulded insert parts have successfully partnered with their robot suppliers to automate and thereby streamline the process, thus reducing direct labour costs and improving quality control (QC). However, the aforementioned relates to common insert overmoulding applications involving normal



▶ Wittmann Battenfeld’s W822 robot with end-of-arm tooling (EOAT) for microinserts. ▶

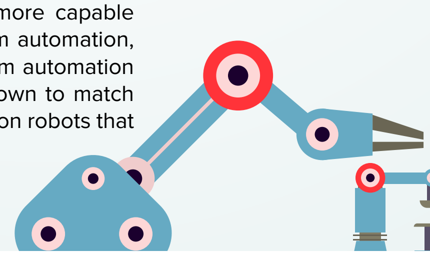
▶ Scale examples of microinserts. ▶



sized inserts and parts. At the other end of the scale are micro-sized inserts and parts, which present a greater challenge to moulders, robot technology and robot suppliers alike.

At the micro scale, of say <3 mm, quite often the insert overmoulding process is still performed manually (or not at all) because of the challenges of automated handling for inserts at such a tiny scale. This means the part often defaults to an assembled two-piece part rather than a single, integrated overmoulded part. Moulders and part designers are not always aware of the capabilities of the latest generation of robots or the ability of suppliers' custom automation engineering groups to manage and successfully implement such workcells.

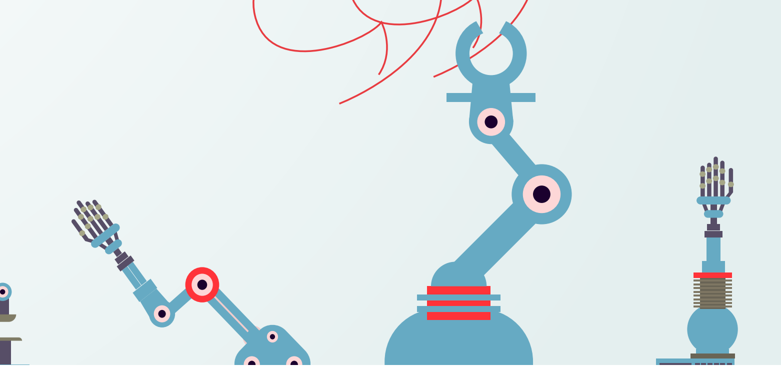
Today’s top-entry linear robots have evolved and are more technologically advanced with higher precision drivetrains (<0.1 mm), multi-axis precision servo technology and software control. From a distance, today’s higher technology, top-entry robots do not appear much different from earlier models of say twenty years ago. However, they are more accurate, more programmable, more capable and easily integrable with custom automation, plus some robot suppliers’ custom automation engineering capabilities have grown to match the more advanced new generation robots that they supply.



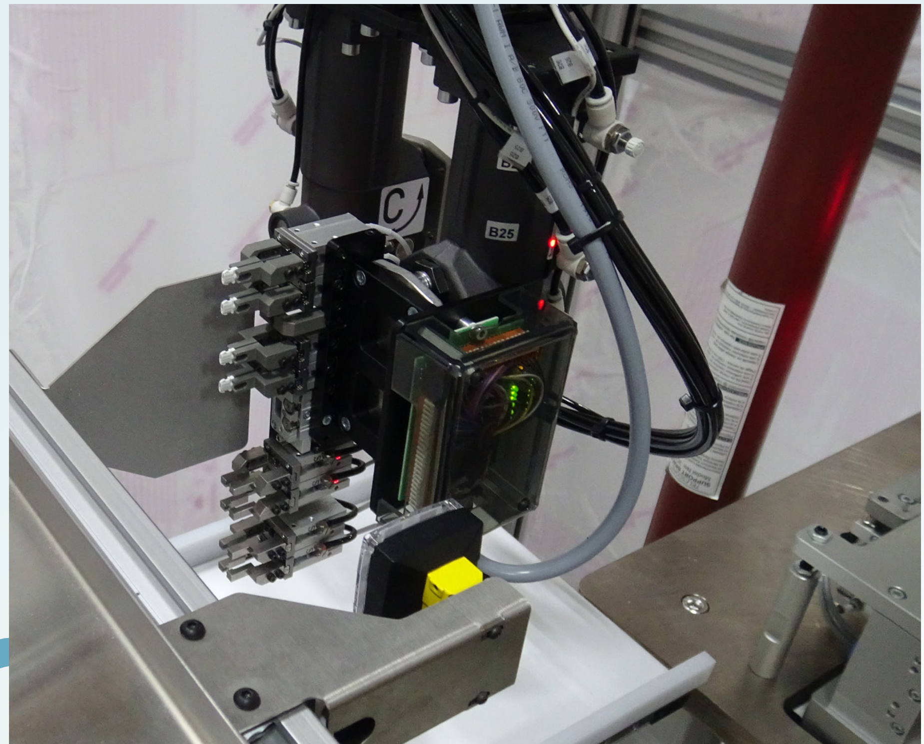
Furthermore, in-workcell devices, QC technology and sensors have improved for more precise insert overmoulding applications. For example, use of more advanced vision sensors, proximity sensors and other high-precision technologies ensures that the inserts are not only present but in the correct location and orientation. Then there is the use of more efficient insert feeders, escapements and end-of-arm tooling (EOAT). Today's top-entry robots and workcells can be equipped to tackle even the most challenging of microinsert overmoulding applications.

Microinsert overmoulding applications, where the insert is of a size that allows up to a dozen or so to fit on a penny, are now being undertaken by design progressive, cost-conscious moulders who have taken the technology lead. These applications are undertaken on 15 to 165 tonne, high-precision horizontal moulding machines with moulds that are smartly designed to facilitate automation for such applications before mould steel is cut and not as an after thought.

> Today's top-entry robots and workcells can be equipped to tackle even the most challenging of microinsert overmoulding applications.



These applications cannot be implemented or managed by all robot suppliers, but there are some that have the expertise and resources necessary to handle all robot and workcell requirements. It is possible for a moulder to have complete confidence in their robot supplier and not have to involve a third-party integrator for microinsert overmoulding applications. Managing a project with one supplier rather than two is obviously simpler.



► *EOAT presenting parts to a single Cognex camera.* ►

► *An insert orientation check.* ►

Microinsert overmoulding project examples

A couple of microinsert overmoulding project examples are outlined below.

Project A

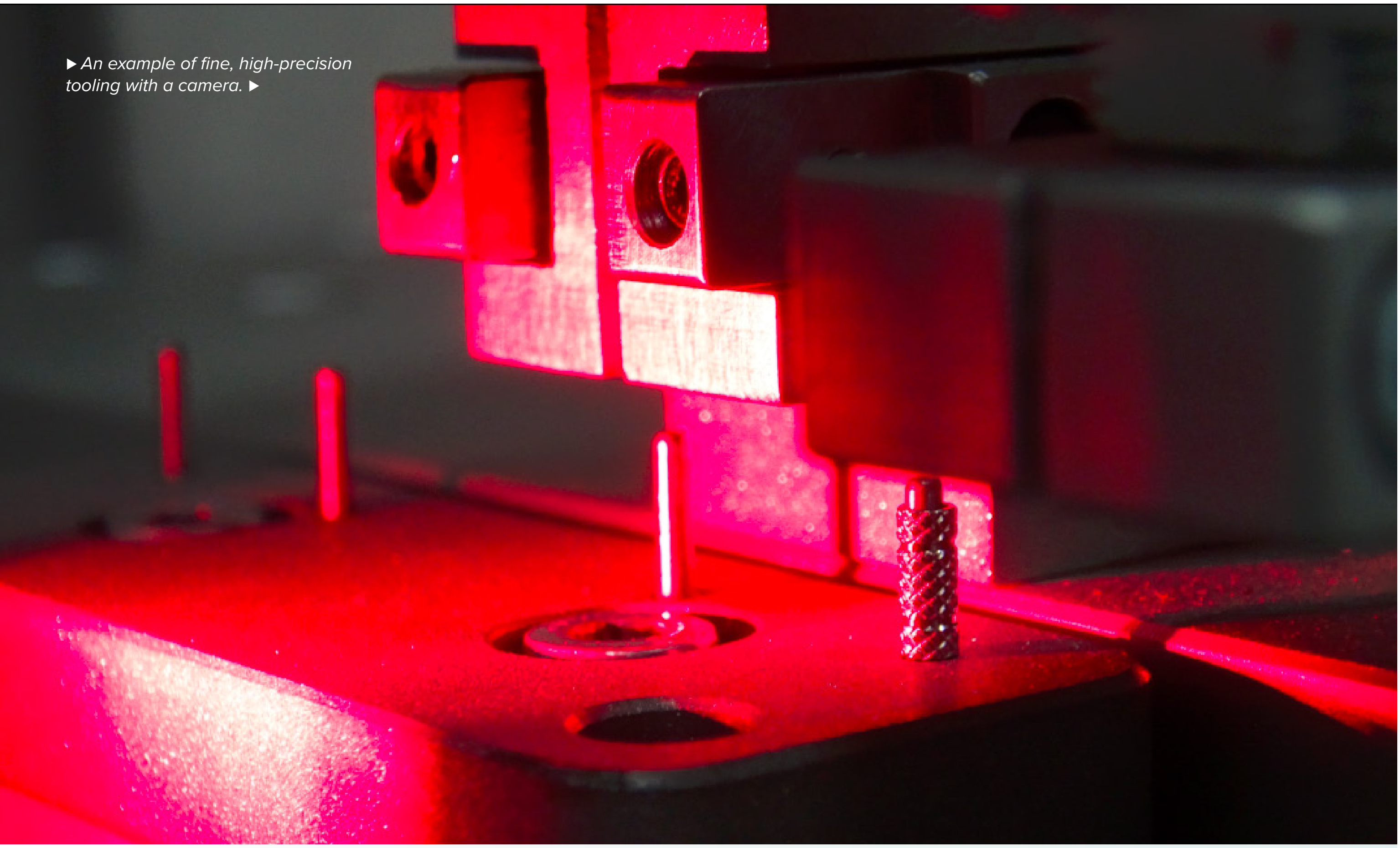
- Electrical part
- IMM tonnage: 110
- Pre-mould insert material: ceramic polymer
- Overmoulded material: polyetherimide (PEI)/ULTEM
- Cycle time: 13s
- Insert size: 1.25 mm/0.0492” dia
- Overmoulded part size: <1.0”
- Tolerance of insert cavity: locational clearance fit: 0.01 mm/0.0005”
- Number of cavities: 8
- Insert shape: cylindrical
- Insert orientation: pre-overmould, front-to-back (axial upon request)
- Quality control vision inspection:

o presence of insert

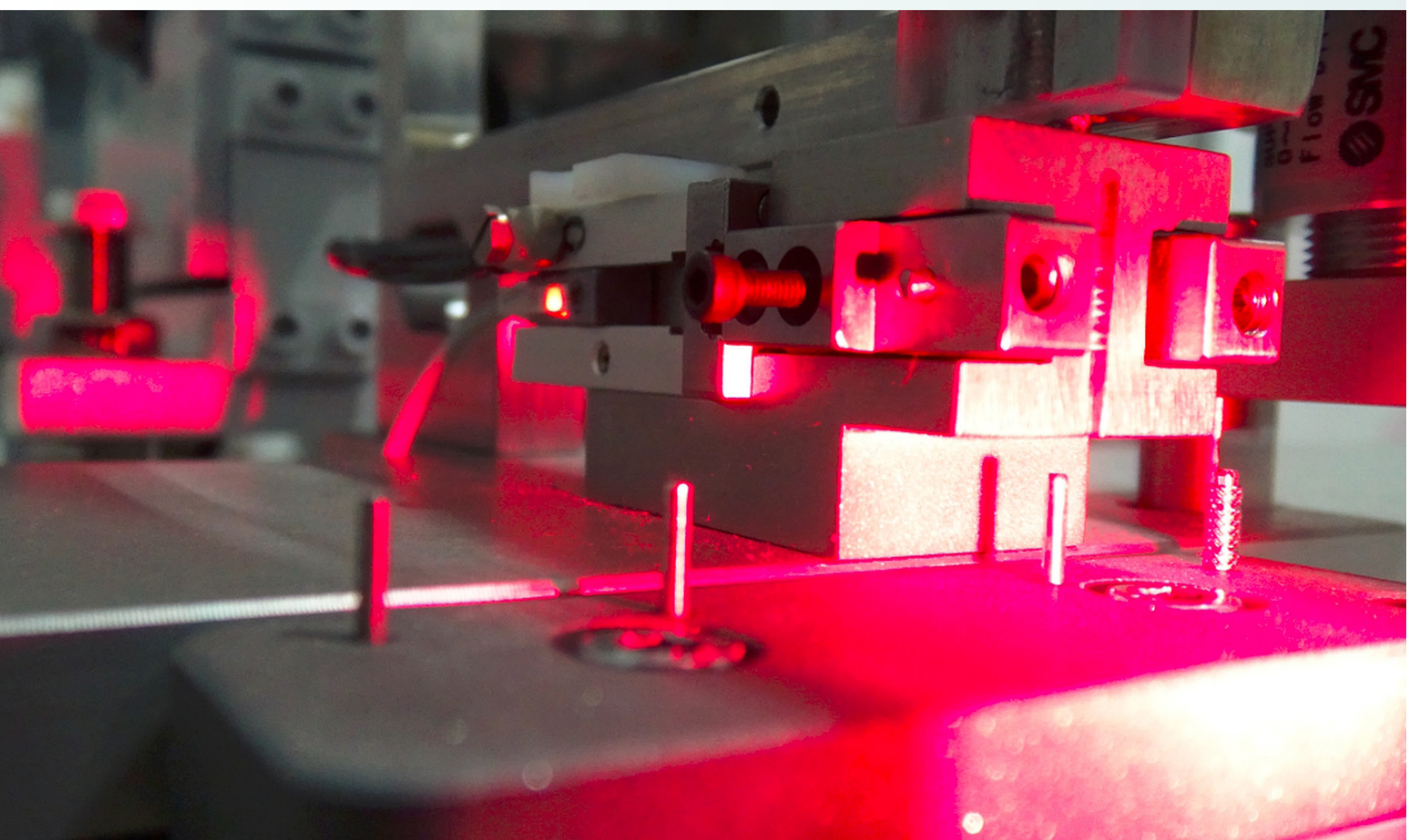
o orientation of substrate in overmoulded part

o other criteria upon request, such as dimensional inspections

- Part release of the overmoulded part: exit conveyor indexing by shot

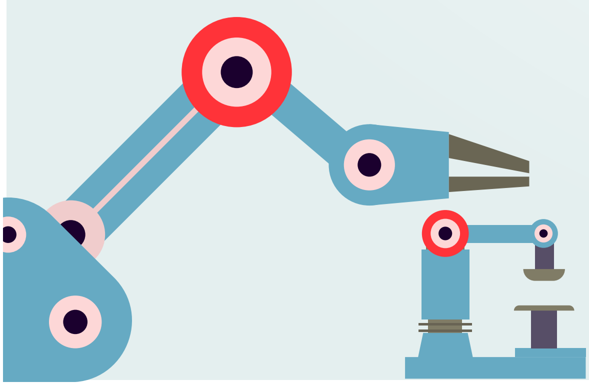


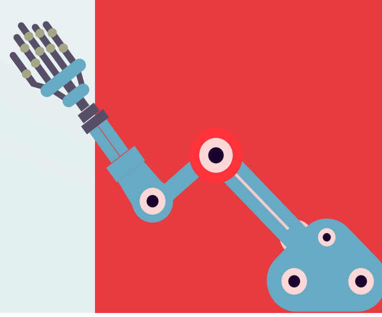
▶ *An example of fine, high-precision tooling with a camera.* ▶



The challenges and considerations of this project include:

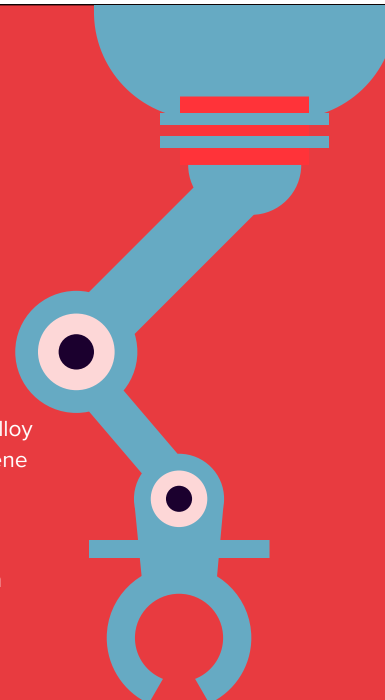
- The pre-mould microinserts must be consistently within tolerance as well as very clean and free from contamination such as dirt, dust, moisture specs and static.
- Each pre-mould microinsert must be kept at the correct orientation as it moves from a bulk arrangement in the automation feeding station and is seated in the mould cavity prior to overmoulding. Robot integrated cameras and vision sensors handle this requirement.
- Careful engineering calculations must be undertaken regarding mould steel expansion thermal deltas as these could affect the tolerance of the cavities, seating of the microinserts and thus quality of the over-moulded micropart; the dimensions and features of a cold mould are not the same as those of a hot mould. This is especially critical when processing at such tiny scales and high tolerances.
- The mould location on the platen must be consistent and perfectly level and square, criteria that must also be met for the mating robot EOAT, even if it has alignment mould engagement pins.
- The EOAT must be machined to very high tolerances (+-0.0005”) and have high-quality stainless steel fingers (as oppose to the standard Delrin, mild steel or rubber ones) and vacuum cavities to make it better suited for overmoulded insert gripping/handling.
- If the insert is especially rough in texture or there is a lot of friction between it and contact surfaces, the EOAT and feeding station sections need to be made of special anodised or hardened materials that are less likely to suffer wear and tear.



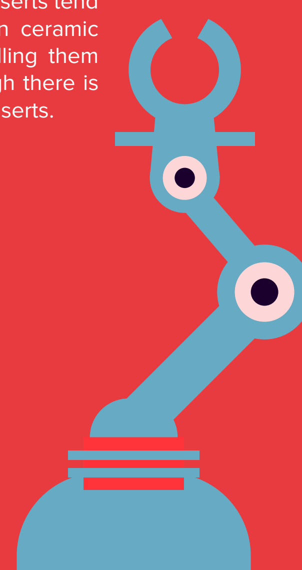


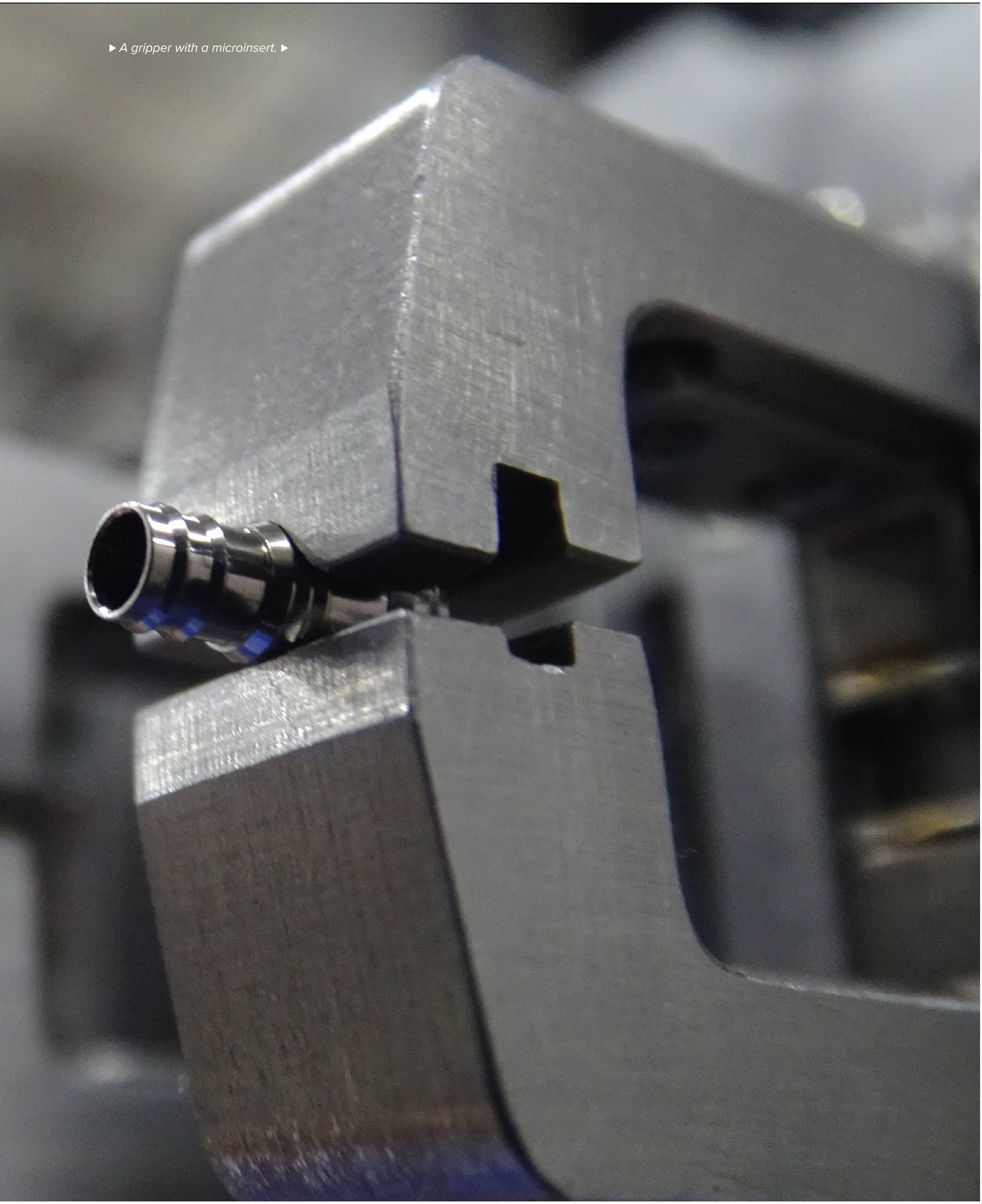
Project B

- Electrical part
- IMM tonnage: 110
- Pre-mould insert material: metal alloy
- Overmoulded material: polybutylene terephthalate (PBT)
- Cycle time: 15s
- Insert size: <2.0 mm
- Tolerance of insert cavity: location clearance fit: 0.03 mm/0.0012ths
- Number of cavities: 4
- Insert shape: cylindrical
- Insert orientation: pre-overmould, front-to-back
- Inspection: orientation from feeding to insert loading via vision sensors
- Quality control:
    - o presence of insert
    - o orientation of substrate in overmoulded part



The challenges and considerations for this metal micro insert overmoulding project are very similar to those of project A. Some of the differences in metal microinsert versus ceramic polymer microinsert handling are qualities such as oxidation and coatings, i.e. metal inserts must be free of contaminants prior to being introduced to the workcell. Sometimes ceramic polymer microinserts are more abrasive than metal microinserts and therefore necessitate the use of hardened contact surfaces. Also, metal microinserts tend to be less fragile and heavier than ceramic microinserts, so gripping and handling them might be a tad less difficult, although there is nothing easy about handling microinserts.





▶ A gripper with a microinsert. ▶

Other common technical challenges and considerations for automated handling of overmoulded microinserts and microparts

Static charge issues

Even the tiniest small static charges can affect the microinsert and micropart, so tests must be carried out to determine if they need to be de-static washed or housed in clean de-ionised air.

Environmental control

Microinserts and microparts are more consistently handled and managed in environments where temperature, humidity and air flow are controlled. For example, ambient temperature changes might change the size of the insert (critical at precise tolerances), humidity might negatively affect any hygroscopic polymers and air flow (from, for example, a nearby door closing or vent) might push the microinsert or micropart out of position. Well-designed workcell enclosures and HEPA filters will often be used to alleviate these risks and for foreign particulate control.

Microinsert QC/consistency

Microinserts must meet high QC specifications (dimensions, flash, debris, etc.) prior to being introduced to the workcell for consistent inserting and handling.

Micropart detection

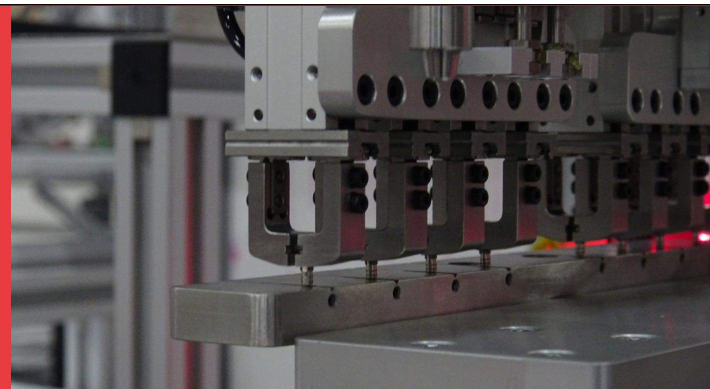
The need for workcell vision cameras or simple vision sensors is determined when testing is undertaken with pilot moulds and/or during the automation design and fabrication process. These technologies are likely to be needed for tasks such as orientation, inspection, mould seating confirmation and post-mould QC. The naked eye usually cannot handle such small-scale inspections.

EOAT finger and gripper precision

The EOAT fingers and grippers are machined to very high tolerances and often made of special materials based on the application requirements.

Microinsert feeder design

Careful consideration needs to be given to the microinsert feeder design in terms of the materials used and high tolerances applied as well as creative orientation management of the precision sensors needed to confirm each step of the process.



▶ *EOAT picking microinserts from the nest.*▶

Mould seating and engagement features

The EOAT often includes a docking feature to dock the mould while locating the microinserts, making for an easier initial setup as well as assured, consistent inserting and demoulding. In addition, the EOAT may not have common mechanical grippers because the microinserts are so small but rather dynamic pneumatic tubes that allow for their more careful transfer and seating in the mould cavities.

Summary

There is a plethora of other fine details that need consideration for optimised inserting, demoulding and handling of microinserts and microparts that an experienced robot supplier can bring to the table during the specifications and design review phase of the project.

Moulders, product design development specialists and mould design engineers, especially in the electronics and medical moulding markets, need to be aware of the possibilities for improved component and product design. New robot and automation technology for microinsert moulding can allow for the realisation of new, barely visible plastic product designs that were unheard of just a few years ago. Now, a tiny part assembly can become a more robust single-piece design with microinsert moulding/overmoulding, reducing post-moulding assembly requirements and the overall part numbers in a finished product. These advantages improve product quality while reducing cost.

A moulder should bring together their qualified robot supplier, product design development specialist and mould design engineer to discuss the possibilities in production microinsert moulding, then do the economic math and move forward. This may give the moulder the competitive advantage they need in their market segment. ●

Wittmann Battenfeld
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