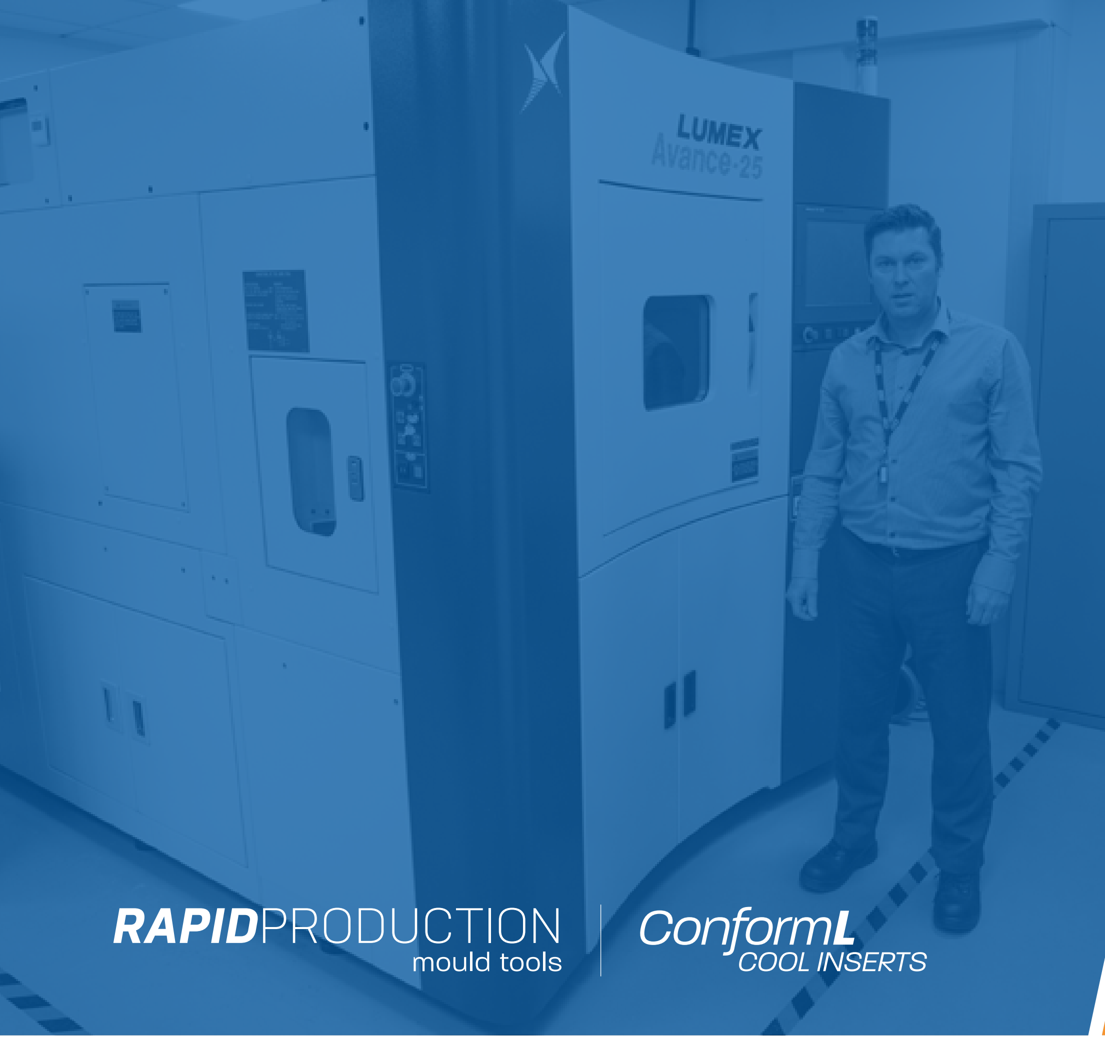
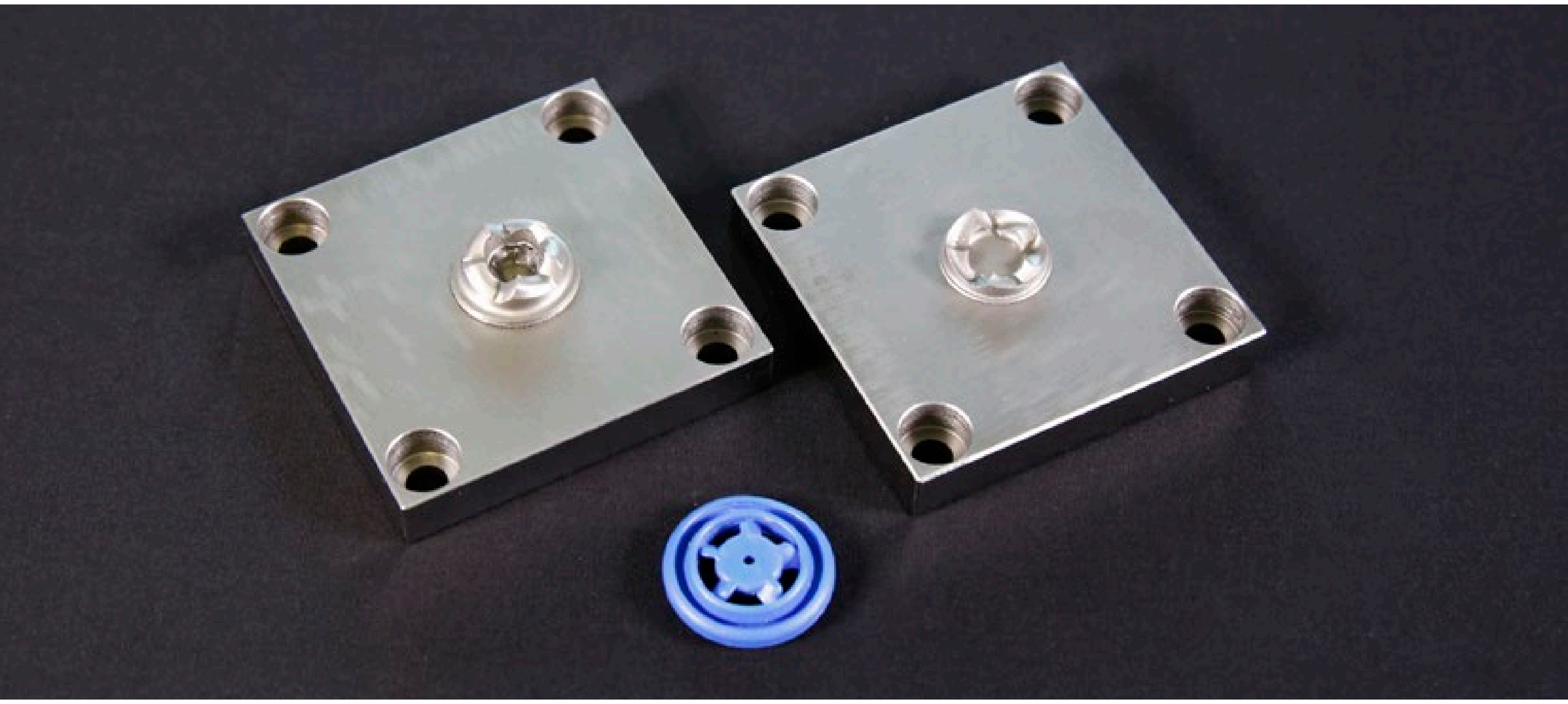


White Paper

Hybrid manufacturing approach delivers cooler tools

OGM MOULDING INNOVATION



A new toolmaking technology is driving up quality and productivity in the production of injection moulded parts.

Water plays a critical but underappreciated role in the plastic injection moulding process. Without it, the technology would not be able to achieve the remarkable levels of quality, productivity and cost-effectiveness that the world has come to rely on.

Once molten plastic has been injected into a mould tool, typically at temperatures of 200 to 300 degrees Celsius, the material cools and solidifies in the mould cavity, gaining sufficient structural rigidity before the mould opens and the part is ejected ready for the next moulding cycle. To achieve the short cycle times required for low cost, high volume parts, cooling water is run through channels in the mould tool, accelerating the solidification process.

> Even minor shrinkage at the corners of a box can lead to significant distortion of the adjacent wall

Rapid, even distribution of cooling is also vital for part quality. Appropriate control of the cooling rate affects the mechanical properties and surface finish of the part. If parts of the material are insufficiently or unevenly cooled within the mould, they can shrink excessively after ejection, leading to distortion, poor tolerances and high reject rates; additionally, with some specific polymers crystallisation will not take place correctly, again affecting mechanical properties and part quality.

Part cooling changes

In conventional mould tools, cooling channels are drilled through the mould material during tool manufacture. This approach is simple, but it creates significant limitations in some part geometries. It can be difficult to run straight cooling channels close enough to the mould cavity for efficient heat transfer, for example, especially when parts have elaborate shapes or lots of complex features.
In many components, cooling channels have to compete for space within the tool with other features, such as ejector pins or moving inserts. That’s a particular problem in the production of box shapes, such as electronic enclosures. In these designs, the best position for the ejectors is usually at the corners, where the structure is strongest, but those points are also the hardest to cool. Even minor shrinkage at the corners of a box can lead to significant distortion of the adjacent wall.

Sometimes, as in the case of the slender cores used to create the internal surfaces of thin hollow parts, it is impossible to provide a straight cooling path through the tool. This requires workarounds during tool manufacture. The toolmaker may drill two parallel channels, connect them with a cross channel and then add material to seal its ends. Or they may insert a baffle into a larger blind hole to create inlet and outlet pathways for coolant. All these efforts add cost and complexity to the mould making process, while some mould features may be too small to accommodate channels in the correct location, leading to sub-optimal cooling.

Poor cooling performance forces moulders into a difficult trade-off, where they need to ask customers to accept a degree of distortion, have to slow down the production process, allowing the part to cool in the mould for longer, or consider both measures. Extending the cooling process inevitably increases the overall cycle time, damaging productivity and driving up part costs.

Conformal cooling

The solution to difficult part cooling challenges is simple in concept, but tricky in execution. Changing the shape of the fluid channels within the mould from straight lines to curves allows them to follow the part surface more closely, wriggle around obstacles like ejector pins, and squeeze into inaccessible areas. This approach, known as 'conformal cooling', has been around for a long time, but it is rarely used in production applications.

The industry's reluctance is the result of the significant manufacturing complexity involved in building tools with conformal channels. Using conventional subtractive machining, conformal tools require the construction of moulds using a laminated design. Channels are machined into blocks of steel which are then stacked on top of each other to create the finished tool. But that approach adds significant time and cost to the toolmaking process, can result in less durable tools, and does not provide a solution for all part geometries.

In recent years, the development of additive manufacturing technologies has provided a new way to manufacture conformal cooling channels. Direct metal laser melting allows the formation of complex shapes from powder materials, allowing channels of almost any shape to be incorporated into a design.

Conventional laser melting processes have their own drawbacks, however. The process is costly and time consuming, for example, and the surface of the resulting tools is not smooth enough for injection moulding applications. That necessitates extensive secondary machining operations, adding further expense and increasingly tool production lead times.

A new hybrid approach

Now a new technology developed by UK injection moulding specialist OGM promises to overcome many of barriers that have prevented the wider uptake of conformal cooling by the industry.

The ConformL Cool approach taken by OGM is based on a new hybrid technique that combines additive manufacturing and conventional CNC machining technologies in an integrated build process.

OGM's manufacturing machine, the first of its kind to be installed in the UK, builds complete steel mould tools or inserts layer by layer using a laser. After each layer is added, however, automated secondary machining processes rapidly remove excess material. The resulting extremely high dimensional accuracy and fine surface finish allow core and cavity inserts incorporating conformal cooling channels to be manufactured automatically in one hit, with no need for separate finishing activities. The material produced in the process is also hard enough (HRC 35) to be used without subsequent heat treatment in many production applications.

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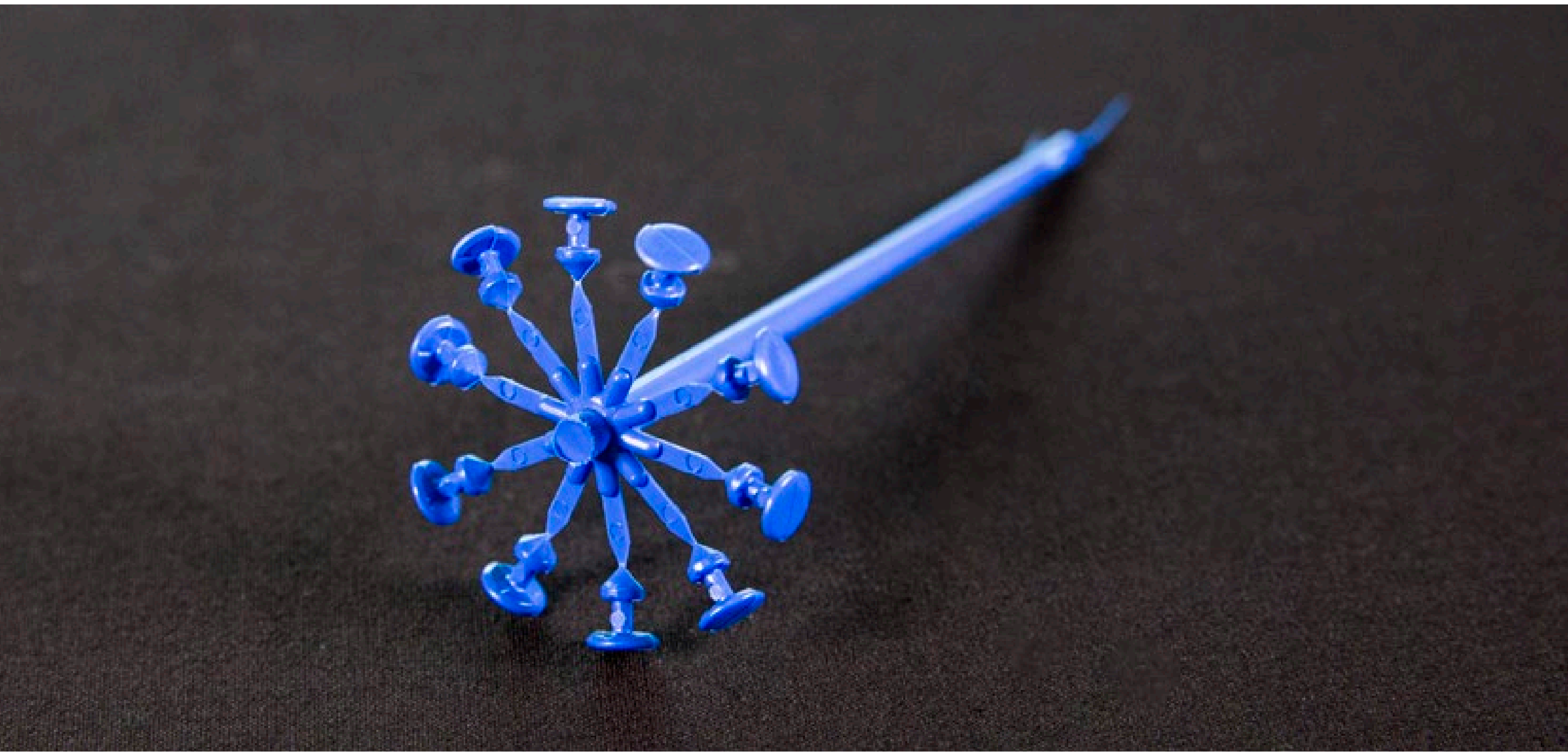


Channel strategy

More than a year of intensive R&D effort has allowed OGM to develop cooling channel designs that make optimal use of the capabilities offered by its new processes. As well as allowing cooling channels to take any route through the tool, for example, the process also removes the necessity for those channels to be round. Elliptical, rectangular and even teardrop designs can maximise heat transfer in different applications. The hybrid manufacturing process also allows better control of fluid flow within the channels themselves. Special features encourage turbulent flow to increase heat extraction while maintaining a smooth surface finish within the channel to prevent blockages caused by mould growth or trapped debris.

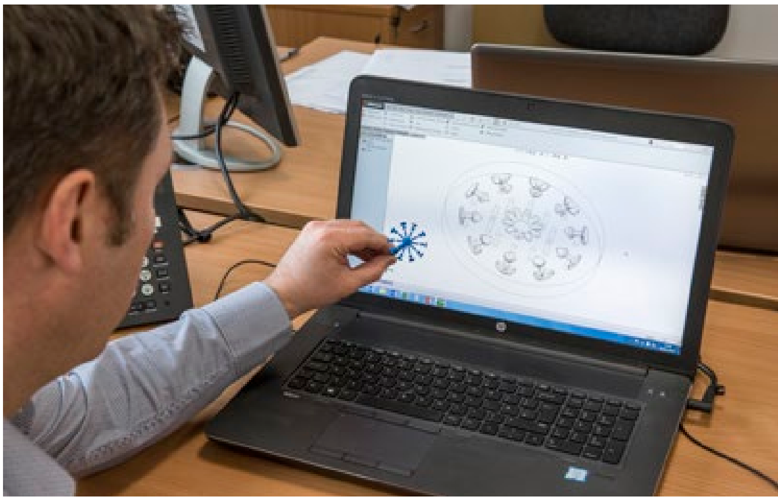
Applying ConformL Cool technology in production applications has already delivered significant benefits, allowing cycle time reductions of up to 20 percent and dramatically reducing defect rates on challenging parts.

OGM is now working on range of solutions designed to make it easier for tool designers and injection moulders to take advantage of this step-change in cooling technology. Those offerings will include custom-built inserts that can be incorporated into conventionally manufactured tools to address hard-to-cool areas, as well as a range of standard inserts including ejector units with built-in cooling channels.

Users and industries set to benefit from the new offerings include any organisation involved in the high-volume production of injection mould parts that include complex shapes, multiple features or tight geometric tolerances. Those applications are found in a host of areas, including consumer goods packaging, connectors and enclosures for electronic products and medical devices.

And while the company's interest in hybrid manufacturing was inspired by the desire to increase quality and productivity through better cooling performance, OGM is already finding other applications for the technology. The ability to build complete mould tools in a one-hit automated process, for example, can lead to significant design-to-part lead time reductions. That could offer compelling commercial benefits for companies operating in fast-moving, time sensitive markets.

Applying ConformL Cool technology in production applications has already delivered significant benefits



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RAPIDPRODUCTION mould tools | Conform**L** COOL INSERTS

About OGM
As one of the UK's leading trade plastic injection moulders, our comprehensive range of injection moulding machines gives us the flexibility to fulfil the diverse scope of our customers' requirements. Processes we carry out include conventional injection moulding, over-moulding, insert moulding and clean room moulding.

We select and source high-quality materials from proven suppliers and have experience in processing most thermoplastics. We manufacture a huge variety of injection moulded parts, including housings, aesthetic parts, two-part mouldings, clear mouldings/lenses, internal technical parts and high-tolerance parts.

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