LSR's Challenge: Educating Part Designers

Why well-established, two-part silicone molding is still not well-understood

By Robert Grace

Victor Morando understands the awesome potential of two-shot silicone molding. He just wishes more product designers did as well. As the chief technology officer of Connecticut molder Dymotek Corp., he is constantly working to educate others about how liquid silicone rubber (LSR) molding may be able to help them solve design challenges.

Dymotek CTO Vic Morando is an LSR evangelist

That's one reason a recent student design competition in Austria involving a few of his company's longtime partners—including Momentive Performance Materials GmbH, machine supplier Wittmann Battenfeld, and toolmaker Elmet Elastomere GmbH—caught his eye.

In a recent interview, Morando said that while Dymotek had nothing to do with the project at New Design University (www.ndu.ac.at) in St. Pölten, Austria, he was fascinated by the concept of the design challenge.

"Most product designers," he asserts, "don't have the knowledge of how you can design with silicone, or how you can design with silicone and plastic in two-shot." Many commonly held beliefs about plastic molding simply don't hold true when it comes to LSR.

"We have so many preconceived barriers to plastic part design, [such as] undercuts are bad, wall sections need to be uniform, etc. When you're designing with silicone, undercuts are no issue, very thin areas and very thick areas can be dealt with in the same way in the same part. Different wall thicknesses in plastic part design can really cause problems with moldability; with silicone, you don't have that issue.

"There are so many unique things about silicone that contradict what goes on with plastic parts, and most people have only designed with plastic parts. So," Morando says, "they leave a lot on the table as regards to what you can leverage with silicone." It's largely a matter of awareness.

As a case in point, Morando recalled how a few months ago, Dymotek presented to a very senior medical device design engineer who has some 30 years of experience in the industry. That engineer is responsible for bringing new technology to some of the younger people in his design group. Yet, after 30 years, "he still was not aware of silicone and that silicone can bond to thermoplastic materials," Morando says.

"He was trying to do a very small fluid flow path between two separate lumens that went into a handle for dispensing these two liquids. It was this tiny, tiny little area, and he's trying to buy O-rings that he fit into this thing so he can get a correct seal, and he's having all sorts of issues. He's buying millions of these per year.

"And we just say to him that we can mold you a thermoplastic part and overmold it with a silicone

gasket that will do exactly what you want. He says, 'Wow, that's fantastic; I never would have thought of that'."

Oliver Franssen, Momentive's senior global marketing leader for transportation, came up with the idea for the design challenge, according to Elmet Sales Director Mark Ostermann. Elmet, based in Oftering, Austria, specializes in making molds, automation, and dosing systems for elastomeric silicones. The company agreed to assume responsibility for key aspects of the project, including designing the part and configuring the necessary turnkey manufacturing cell.

Austrian tool maker Elmet Elastomere GmbH made the mold needed to make the winning, two-component "Butterfly" cellphone holder using flexible LSR and rigid polycarbonate.

The parties decided to engage with the New Design University, a progressive-minded private institution. A total of four NDU student groups participated in the project, which spanned three and a half months, Ostermann said. The companies challenged the participants to come up with how best to leverage the numerous attributes of silicone, including its elasticity, friction and soft-touch grip, dampening characteristics, transparency and colorability, and impact resistance, as well as its ability to bond firmly to rigid thermoplastics.

The early student mockups of possible designs included these wood and felt models. All photos courtesy of Elmet Elastomere GmbH

In fact, Ostermann explains, "The goal was to create a part that shows the perfect chemical bonding between polycarbonate and LSR, as well the robustness of PC and the sealing, haptics, suspension, decoupling, or encapsulation of the LSR. Further, the plan was to demonstrate that LSR can be used as a spring 'rubber band' and demonstrate its very good mechanical properties."

Participants were instructed to design a smartphone holder that could be fixed to the dashboard ventilation grille of any conventional car. They were told it had to be able to rotate for horizontal and vertical use (such as for a navigation system) and to adjust flexibly to fit current smartphones. The brief called for the final part to be a single piece that did not require any assembly or post-production finishing.

The winning entry—submitted by student Georg Siegele—leveraged all those attributes, in a sleek, functional way. He conceived a cellphone holder with a rigid, polycarbonate spine, bonded to LSR that forms what look like four wings that can be stretched over each corner of the phone—hence the product's "butterfly" nickname. The PC clamping device on the back side of the holder has a wedge form, that allows the grille slats above and below to help secure the device in place.

In a recent interview with Germany's GAK - Gummi Fasern Kunststoffe magazine, Siegele offered the following explanation of his concept and approach:

"My target was to design the part as simple as possible and strip it down to the bare functions required only. This triggered the idea of complete symmetry. Then I hit on the idea that the overall shape with its four flaps has basic similarities to a butterfly. It has a symmetry and can be mirrored in all axes. Butterflies also at least have two identical halves and thus reflect uniformity and symmetry. They go through a metamorphosis from caterpillar to butterfly that finally crawls out of its pupa and flies away.

New Design University student Georg Siegele won the design challenge by focusing on simplicity and symmetry.

The injection molding process could be compared to a similar metamorphosis in which the finished object finally falls out of the injection molding tool and is then ready for its final purpose."

Morando notes that normally, if a product designer were challenged to design a cellphone holder that would work in almost any car vent, few would think about silicone. "Most would likely look at plastic materials like Santoprene or other TPVs or TPRs or maybe even a thermoplastic urethane, and it still would not perform as well as the silicone and the LSR material, because it's a true rubber and not a plastic material."

For the winning product, Momentive supplied its Silopren LSR 2759 material, which affords primerless bonding to polycarbonate—in this case, Covestro's Apec 1745 resin. The LSR provides damping, elasticity, haptic feedback, and interacts as an adhesive and as a soft-touch surface, potentially in various colors. The transparent polycarbonate, meanwhile, provides stability and allows the part to be mounted on the ventilation grille, while offering a combination of stiffness, elasticity, and temperature resistance.

Elmet teamed with Wittmann Battenfeld to devise the optimum production cell, including the needle-valve, cold-runner mold and the LSR dosing system. Covestro provided the polycarbonate and engineering resin expertise, while software provider Sigma Engineering offered advice on design and on the simulation of the material flow behavior. Hasco Hasenclever GmbH + Co. KG assisted with the gating of the hot-runner system for the thermoplastic injection molding process.

Elmet—which also has offices in Taiwan, China, and Lansing, Mich.—molded the winning, two-shot part in a 40-second cycle on a Wittmann Battenfeld SmartPower Combimould 120/130H/210S injection press with a Unilog B8 control unit. Both injection units were mounted on the same machine, in a piggyback setup. Elmet equipped a Wittmann Battenfeld three-axis demolding robot with one of its own demolding heads, to provide the high precision that is typical of silicone injection molding.

The cellphone holder's wedge-shaped, soft-touch "nose" is designed to snugly grasp the air vent grilles on nearly all current vehicle models.

The holder allows the phone to be mounted vertically or horizontally (above). This view clearly shows how the Butterfly's "wings" grasp the corners of the phone (below).

The result is a lightweight, minimalistic product that does just what it is supposed to do—securely hold a variety of cellphone models to different types of dashboard grilles.

Momentive ran the fully automated, turnkey production cell on its stand at October's K Show in Düsseldorf, Germany, and drew large crowds to view it. Both Elmet and Wittmann Battenfeld also provided the cellphone holder as a giveaway at their K booths. The entire production cell is now back at Elmet's Austrian headquarters facility, awaiting installation so it can mold more parts, Ostermann said in early December.

Morando thinks the product is highly sellable—and the parties are indeed considering commercializing it, Ostermann says.

Typically, Morando notes, for two-shot LSR molding, you need hundreds of thousands of parts per year to justify the tooling cost. It does depend, however, on the amount of value added (e.g., for

Elmet says it is considering taking the Butterfly holder commercial. If it does, the novel cellphone holder just might fly off of retail shelves.

a critical medical or safety part), "so it's possible you could justify 50,000 parts per year."

While many use the phrase "design for manufacturability," Morando says Dymotek coined the term "design for function." Despite the process's many apparent advantages, he notes, "Industry has just begun to design products that fully take advantage of silicone and the silicone molding process."

He is only too happy to recount some of the positive design aspects of the material and the process, including:

- Capable of molding extreme undercuts
- Long, thin flow lengths and small, fine product details
- Great high- and low-temperature performance
- Self-lubricating materials
- Two-shot eliminates assembly and reduces part count
- Thick and thin wall sections in a single part is acceptable
- Near zero residual stress molding creates exact geometry in low-durometer material
- UV cure is low pressure and low temperature
- Applications related to liquids or gases (air)

With two plants in Connecticut, 30 injection molding presses, about 135 employees, a newly installed class 8 clean room, and $25 million in annual sales, Dymotek alone does not have the heft to move the market. But it will not find a more devoted evangelist than Vic Morando.

With an engineering team of about 15, Dymotek offers design assistance to people making assemblies of both plastics and silicone rubber. "We're medical focused," he says, "but we're active across all markets. If you're controlling fluids or air, we typically can do something there."

Morando also notes that his company recently began micromolding two-shot silicone and plastic. In his mind, that simply means very tiny, two-component parts that may equal big business. The key now, he suggests, is simply to effectively convey word of this "fantastic, niche material" to open-minded product designers and engineers worldwide.

ABOUT THE AUTHOR

Robert Grace is a writer, editor and marketing communications professional who has been active in B2B journalism since 1980. He was founding editor of and worked for 25 years at *Plastics News*, serving as editorial director, associate publisher and conference director. He was managing editor of *Plastics Engineering* from July 2016 through October 2017, and is now both editor of SPE's *Journal of Blow Molding* and directing content strategy for SPE. He runs his own firm, RC Grace LLC, in Daytona Beach, FL., and can be contacted at bob@rcgrace.com.