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INJECTION Molding

FOR INJECTION MOLDING PROFESSIONALS

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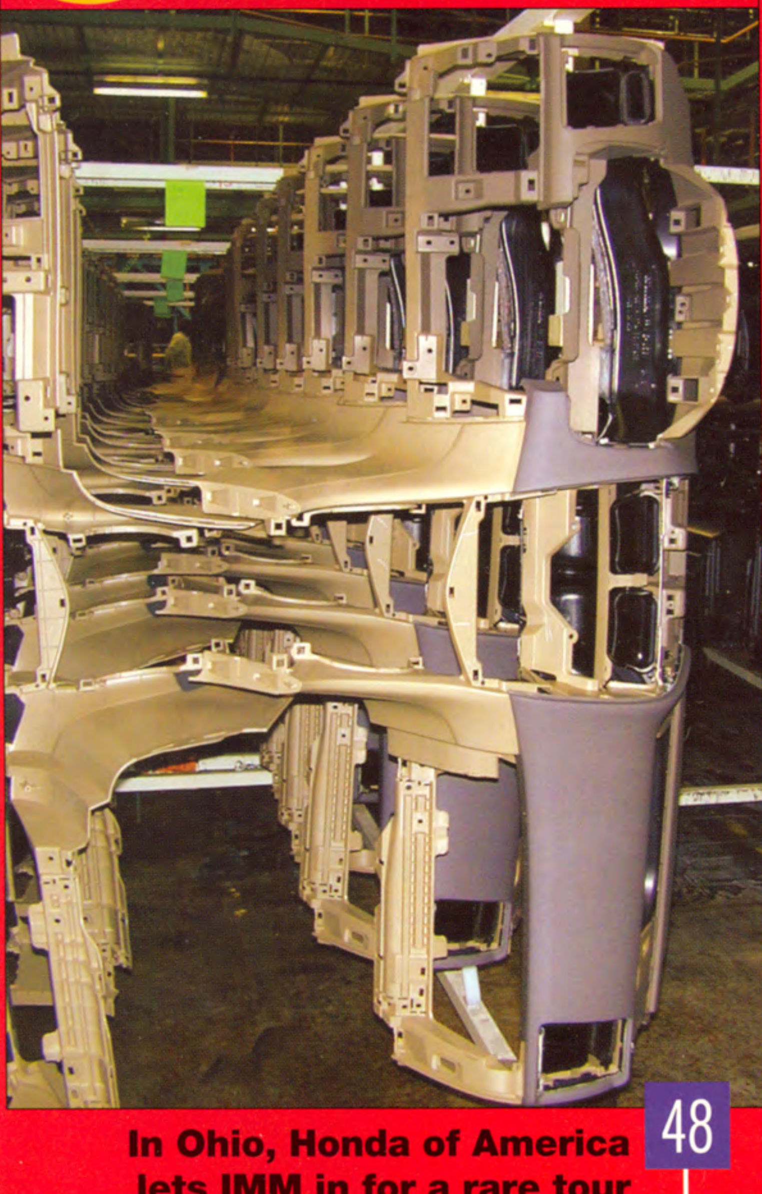

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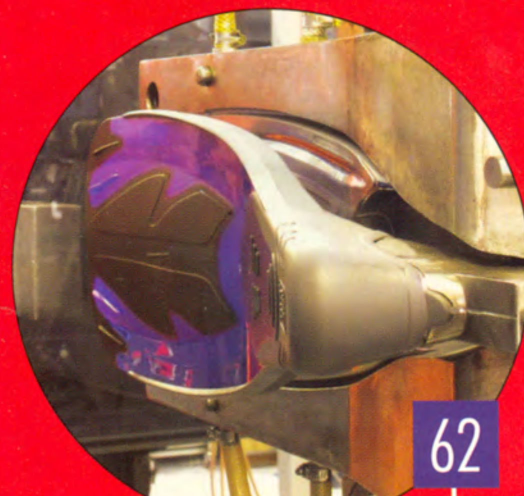

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Basic Elements: Zero tolerance: A new way of looking at precision

By: Clare Goldsberry (www.immnet.com/articles?article=2334)

To say we are all used to plus/minus tolerancing is a drastic understatement, yet as demands on quality rise, and many parts shrink and become more complex, our old ± may not cut it anymore.

We live in a world of precision. But just how precise are we? Not very, according to Greg Hetland, Ph.D. and founder of the International Institute of Geometric Dimensioning & Tolerancing (IIGDT) in Hopkins, MN.

In fact, the old system of tolerancing—plus/minus dimensioning—is basically a CYA system. It has been the standard for 100 years, in spite of the fact that geometric tolerancing was developed more than 50 years ago in answer to the problems created by the plus/minus system.

"Manufacturing has not improved at the same rate that tolerances have gotten tighter," he adds. "So, we're at a point of diminishing returns. Dimensions are no longer precise enough to achieve what manufacturers need with molded components getting smaller and assembly requirements becoming more critical."

So how should moldmakers go about implementing geometric dimensioning and tolerancing (GD&T)? Hetland offers the following advice:

- **Invest in GD&T training.** Hetland started the IIGDT to help standardize geometric tolerancing through in-house seminars and programs. He takes these on the road to groups and companies that need to know how GD&T can improve their products and their bottom line. He's also teaching college professors in an "educate the educator" program. "People coming out of colleges are not being trained in geometric tolerancing, even at the most basic level," he says.

  "People using plus/minus tolerancing assume they know what it means," Hetland explains. "The plus/minus tolerancing is intended to identify the variation, but the problem lies in the fact that it does not control the inter-relationship between other plus/ minus-toleranced dimensions."

  Investing in GD&T training results in higher profit margins by increasing capabilities, competencies, and efficiencies; boosting yield and reducing scrap/rejects through the ability to predict and control processes; and decreasing misunderstandings and production delays by means of increased confidence levels—a direct result of skills enhancement.

- **Learn the language of GD&T.** Hetland finds that part/mold designers and moldmakers generally don't understand geometric language. Moldmakers tolerance off many areas including holes, surfaces, and guide pins, but because of the system, there's always ambiguity in the mold build (see sidebar, left). "The plus/minus language isn't precise enough to allow a mold-builder to manufacture cores and cavities to exact dimensions," he says.

  Yet, most moldmakers say, "Give me an exact dimension and I can hit it," notes Hetland. Mold shops, for the most part, have the equipment to perform these exacting tolerances in a repeatable scenario for multi-cavity molds, where interchangeability is critical. True interchangeability requires exact dimensions and unambiguous tolerancing.

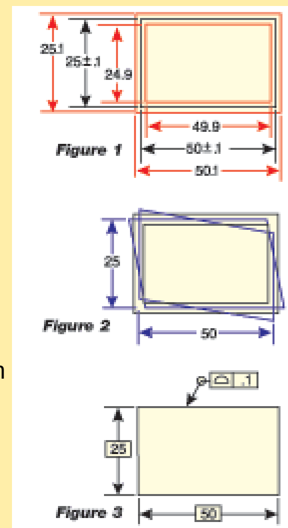
- **Invest in the right equipment.** Invest in computer-aided, high-speed machining equipment with the capability to hold the tolerances and a CMM that can help you measure GD&T. "We're assuming the company has the ability to produce the cores and cavities to GD&T and then measure it," Hetland says. In fact, interchangeability of cores and cavities practically becomes a non-issue with the implementation of GD&T.

One of the big problems is mold shops using measurement devices that in no way can measure the components to the tolerances specified. “In one instance, a mold shop had the manufacturing capability, but when I asked them how they measured these features they said, ‘We don’t—we can’t,’” Hetland adds.

- **Learn how to measure GD&T using the equipment.** These plus/minus tolerances have been a means of process control, Hetland explains. “But process control doesn’t mean anything if you don’t have the overall tolerancing capability to begin with,” he says. “I suggested they look at a coordinate measuring machine that is capable of measuring the tolerances that were required; to get beyond plus/minus tolerancing and learn how to measure it. Without precise definition of design requirements and truly capable measurements, it’s not clear they conform to the true engineering requirements up front.

“By using GD&T we can provide unambiguously defined tolerancing that is manufacturable and measurable, and eliminate the rework,” Hetland states. “Plus/minus tolerancing runs the gamut from ‘what you really mean’ to ‘what we thought you meant.’ Anything in between is rework. And, most moldmakers have talked themselves into believing rework is an acceptable practice. But then we lose money—and ultimately business—to China."

Why precise terminology is critical



The following is an example of how using specifications according to the U.S./International Standard for geometric dimensioning and tolerancing (GD&T) can result in a part different from the designer’s intent. Figure 1 shows a shape requiring variation not to exceed an inner and outer boundary of concentric rectangles (25 ±.1 and 50 ±.1). While the drawing reflects the desired boundaries, it would be incorrect to assume it to be the allowable set of boundaries.

The GD&T Standard defines these particular features (two sets of parallel planes) as they are dimensioned and toleranced as two independent features of size. When only a tolerance of size is specified, it does not control the orientation or location relationship between individual features. Figure 2 shows that an individual feature of size can fit within its allowable tolerance of ±.1 mm, but also fall outside the perceived outer boundary in the opposing direction.

The solution is to use precision GD&T as shown in Figure 3 with a Profile of a Surface control of “.1 mm all around,” which applies to the basic dimensions specified. Profile tolerance applies perpendicular to the nominal geometry and its default definition applies bilaterally, which means the tolerance is divided equally (±.05 mm) around the entire nominal geometry. Thus the derived boundary shown in Figure 1 now matches the boundary originally desired by the designer. None of the undesirable conditions shown in Figure 2 is allowed by this profile tolerance. The result is design intent that can be clearly defined by the designer and unambiguously interpreted by all other supporting technical disciplines.

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