

How Do You Make the Perfect Gear?



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Okay, I'll admit it. It's a trick question, because of course there's no such thing as a perfect gear. There will always be manufacturing errors, inconsistencies and human error. Tools and machines wear down, so that the first gear you produce will always be different from the one hundredth. Every time you change a tool or clamp a new workpiece, you introduce more opportunity for error. And those errors all stack up: machine, tooling, workholding, gear blank, etc., are all in a constant state of change throughout a manufacturing run, whether we're talking about a single piece or 10,000.

So you can't make a perfect gear. But even if you could, you would never know, because you can't measure one, either. Inspection equipment is made up of moving parts, so it's subject to the same problems as manufacturing equipment. When you introduce other variables – like the temperature of the room or the part being measured – it becomes clear that not only can you not measure a perfect gear, but neither can you measure an imperfect one the same way twice.

But it's not all bad news. The problem is really in the question. If I'd asked, "Can you make better gears, consistently and at an affordable cost?" the answer would be undeniably yes. And if you want to know how, this issue of *Gear Technology*, with its focus on quality, is certainly a good place to start. Whether you're looking for answers on the shop floor, in the inspection lab or for high-volume or low-volume production, we've assembled a batch of articles that can get you thinking in the right direction.

Duane Veit's article (p. 10) shows how a simple hand-held gage can improve and speed up the process of measuring gears over balls or pins. Traditionally performed with a micrometer, building the technique into a repeatable hand-held gage allows for the checking of parts even while they're still on the machine, allowing operators to catch problems in-process.

In "The Measure of Success," Senior Editor Matt Jaster interviews the experts in metrology software at Klingenberg to find out how gear inspection in the era of Industry 4.0 has kept pace through the use of advanced software and closed-loop processes (page 22).

Klingenberg has also contributed a short article on the company's hybrid inspection systems (page 26), whereby the repeatability and accuracy of physical probes is combined with the speed of optical metrology to provide highly accurate inspection capabilities at production volumes.

Gene Hancz of Mitutoyo explains the role of the CMM in modern gear inspection in his article, "Mitutoyo Examines Modern Gear Measurement," beginning on page 28. Hancz explains why the use of CMMs in gear manufacturing environments will likely increase due to the increased need for higher quality across many industries, as well as the increased use of nonstandard or modified gear profiles across those industries.

Measuring what you've made is surely an important part of gear quality and all of the above-mentioned articles go a long way toward helping you do just that. But equally important in terms of gear quality is designing your gears to meet the needs of your application in the first place. Because even a perfect gear doesn't remain perfect once it's out in the field. Its operation is greatly affected by lubrication, temperature and other factors.

That's why this issue's technical articles are equally important in terms of understanding gear quality. In his article (p. 54), Hanspeter Dinner of KISSsoft presents a comprehensive review of recent changes to ISO 6336, the leading global standard for the rating of cylindrical gears.

Also, the team from Mondragon University in Spain has written an in-depth research project about the effects of thermal distortion on small-size steel gears and how temperature affects quasi-static transmission error (page 34), crucial information for industries such as automotive and aerospace where pitch-line velocities of gears continue to increase.

Ultimately, every aspect in the life of a gear has an impact on its quality, from design to manufacturing, inspection and right on through to end use. We hope this issue has provided you with some insight into how you can keep pushing your gears closer and closer to perfection.