Updating Modern Production Processes

Liebherr Touts Automotive Technology in 2016

Matthew Jaster, Senior Editor

AGMA's Fall Technical Meeting (October 2-4, Pittsburgh, PA) will once again provide a noteworthy platform for sharing the latest technology on gear design, analysis, manufacturing and the application of gear drives and related products.

Dr. Andreas Mehr, technology development, gear grinding and shaping, at Liebherr, will be presenting his paper "Efficient Hard Finishing of Asymmetric Tooth Profiles and Topological Modifications by Generating Grinding," during the event. This paper will examine new possibilities of modifications with the continuous generating grinding method including deviation-free topological grinding (DFT), generated end relief (GER), noise excitation optimization (NEO), as well as the hard finishing of asymmetric gears.

Gear Technology recently caught up with **Scott Yoders**, vice president of sales, Liebherr Gear Technology, Inc., to preview some of these new advancements, reaffirm some tried and true gear manufacturing methods from Liebherr and discuss the company's role in the automotive industry moving forward.

Gear Technology (GT): Briefly explain some of Liebherr's latest grinding technologies and how they are being applied to the automotive industry?

SY: When making X-axis movements during generating-grinding — such as lead-crowning — you induce a sometimes unwanted "twist" into the tooth profile. To counteract that phenomenon, years ago (1987 in fact) Liebherr invented twist-free grinding, using the diagonal grinding method with a pressure-angle corrected tool, which can be applied to any automotive gear applications with lead crowning. (By the way, almost ALL automotive planets nowadays have lead crown.) When modern corundum tools for generating- grinding became the standard in industry, Liebherr updated this pressure-angle corrected software for use in high volume *dressable* applications with twist-free. With Liebherr's leadership in the field of twist-free grinding, we were recently able to build on this experience and introduce "deviation-free topological" or DFT grinding for the twist-free method. From our experience with customers, it was known whenever you grind twist-free, you sometimes lose microns on the profile crown. Early on, our customers had to use a special dresser design to correct the profile crowning that was lost during twist-free grinding. On a side note, this is something that our competitors will run into once they start really getting into this twist-free grinding. They will have to utilize a special dresser in most cases. But now from Liebherr — with DFT grinding — we can use *standard* dressing tools and simple programming corrections to give the customer what they want, a truly "deviation-free" untwisted part.

GT: Was this process then adapted and applied to generated end relief (GER)?

SY: Yes. That was the next step with DFT grinding from Liebherr. End-relief is well known in the gear industry. Take a helical gear, for example, if you put an end relief on the tip and root on opposite flanks you can increase the load carrying capacity of the gear, with an even thinner face-width. This is well known in big industrial gear applications (such as the wind energy market). End-relief corrections like this have always been possible in profile grinding, but it is performed one tooth at a time for big gears and the method was always too slow for automotive applications. The idea was to bring these end relief corrections to modern high volume generating grinding. When we introduced DFT grinding, we had the additional idea to pioneer what we call Generated End Relief — or, GER. It's working very well currently with some of Liebherr's automotive customers. We began our first tests in 2015 and it's providing great results in 2016.

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GT: What's going on regarding asymmetric gears in the automotive industry?

SY: It's coming. There will soon be a very large demand for these with our automotive customers. It's not new at all to tractor manufacturers. Liebherr machines have been up and running in production with tractor manufacturers for some time now. This is for gears designed for turning in one direction only, like we see in automotive planetary gearboxes (where there are clearly defined "drive" and "coast" flanks). Here we have a drive flank and coast flank, and the designer can optimize the pressure angle on the left to right flank and increase load carrying capacity. Again, this is well known in gear manufacturing, but we've applied it to modern generating grinding. The math is highly complex.

GT: You discussed noise excitation optimized modification with *Gear Technology* last year, what's the latest news regarding this?

SY: This is a process introduced by Liebherr for topologically grinding-on a specific wavelength and amplitude on the tooth flanks in both the profile and lead direction. Typically, you don't want waviness, you ideally want a straight line or ZERO for the ffa and ffB values. But here we're grinding specific ffa and ffB values into the part — on purpose — as a sort-of noise canceling feature. We're well aware of our automotive customers asking us to decrease gear noise and we've developed the mathematics to make this work in the continuous generating grinding process, together with the FZG in Munich. We're excited about the possibilities and this will be shown in-depth during the FTM in Pittsburgh. We look forward to discussing it more in detail with attendees this fall.

GT: Any other technologies or machine tool advancements that your automotive customers seem particularly interested in today?

SY: Even though our ChamferCut process in hobbing was introduced back in 2005, I recently saw several attendees at a trade show in Mexico interested in the product. We have all of these new technologies and gear developments and sometimes, it's an older product that people may have missed that gets the most attention.

We developed the ChamferCut with Fette and now it can be done in parallel — simultaneously — with the hobbing process which means the chamfering time comes along for free. This is burr-free chamfering and you don't need a second cut. Everything else in the market (roll press deburring, for example) is not really a true cutting process. This is specifically suited for automotive, but we see interest in aerospace as well as the truck market.

GT: What is Liebherr's role in developing and improving grinding technologies specifically for the gear market?

SY: You want to be careful when you hear about new and noteworthy advancements in the gear indus-

Machine demonstrations on the LGG 280 will be available during IMTS 2016 in Chicago from September 12-17.

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try today. It's important to do a little research. Twist-free grinding is a great example of this. Liebherr patented twist-free grinding way back in 1987 courtesy of Dr. Gerd Sulzer. This is nothing new from Liebherr, but there are others in the market saying it *is* new today.

During twist-free grinding the pressure angle (and therefore the resultant workpiece profile) is continuously changed along the entire worm length. The process uses the diagonal method (this has no impact on cycle time, but tool life is slightly reduced with corundum worms). The natural twist is eliminated.

Additionally, Liebherr invented the polishing of gear flanks during generating grinding back in 1988. This was applied with updated polishing abrasives for modern production processes with corundum some years ago. Some companies are showing this technology that Dr. Sulzer invented as absolutely new which is not really the case.

GT: There has been much discussion recently on the reliability and repeatability of one-table solutions in the gear industry. Where does this fit in with your automotive customer base?

SY: Naturally there is a higher process capability with a single table than with two. This is inherently from one single stream of process variation in the data. As automotive manufacturers and suppliers are noticing a reduction in tolerances for all gear features, this higher process capability is not a wish, but rather — more and more — a requirement.

It is also our thinking that the machine has less idle time for changeovers, less durable tooling (i.e., less fixtures needed) when a machine is producing multiple part numbers, and less process instability due to fixture wear issues and less mechanical movement. Much like the KISS method — we believe in simplicity of design at Liebherr.

GT: Finally, what can we expect from Liebherr at IMTS in Chicago this fall?

SY: We look forward to having discussions on all the technologies we've recently developed with our gear customers at IMTS. We also look forward to demonstrating the capabilities of our LGG 280 gear grinding machine and Wenzel's WGT 280 gear inspection machine. (*Editor's Note: For further information, check out Liebherr's IMTS Booth Preview on page* 64).

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