

Making Room for Productivity and Quality Requirements in Gear Grinding

Matthew Jaster, Senior Editor

Gear grinding comes with unique production challenges today. Customers often request higher and faster speeds for continuous generation gear grinding. They also struggle to find a balance between productivity and quality requirements. While many applications are utilizing *less* gears in their equipment, the quality and production values continue to increase. Therefore, the gears found in the automotive, aerospace and industrial segments in 2021 need to cost less, reduce gear noise and work as efficiently as possible. As with any other area of manufacturing, gear manufacturers are going to need the right tools—in this case grinding wheels, spindles, hobs, etc.—to meet greater production demands in 2021.

Norton | Saint-Gobain Abrasives Develops Grinding Innovations

Norton | Saint-Gobain Abrasives has been developing innovations in grinding wheel technology, including advances in abrasives and bond technology. The global company is able to leverage the technical expertise from its R&D facilities around the world. Developments include new advancements in grain, bond and porosity technology.

“To meet the changing and ever stringent demands on the gear industry, we



The 3M Nano 2.0 Series features a newly developed bond system that allows the company to reduce the amount of unloved bond volume.

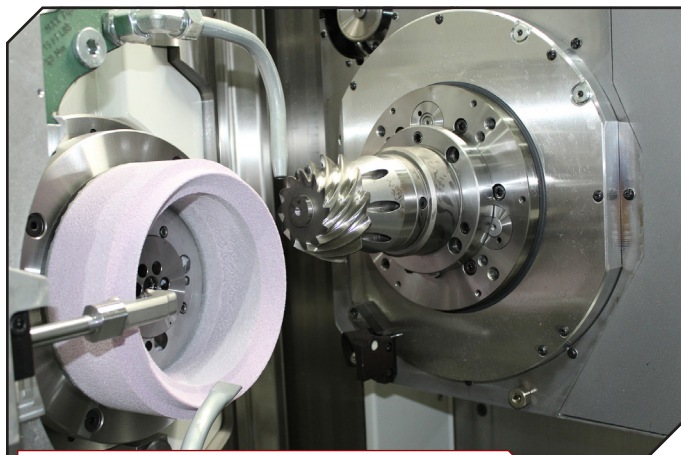
have invested heavily in our production lines for gear grinding wheels at our plant in Worcester, MA U.S.A. High wheel speed at 80 m/s has become the industry standard, and OEMs are providing grinding machines at even higher speeds. Each worm wheel follows the strictest quality control procedures to deliver perfect geometry, balance, and safe grinding at high speed,” said Andrew Biro, senior applications engineer, Norton | Saint-Gobain Abrasives.

With the electrification trend gaining momentum, the transition to hybrid and electric vehicles will create new

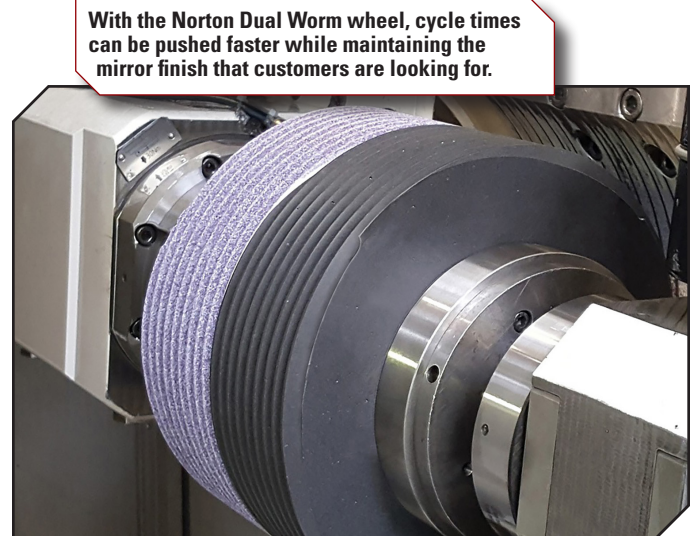
challenges for the gear industry.

“Our customers are often struggling between high productivity and high quality. Both are desired, but not always achievable together,” said Josh Fairley, product engineer, Norton | Saint-Gobain Abrasives. “Our experienced Norton teams are trained to help customers meet their stringent quality standards as well as productivity goals at the best total cost.”

With the Norton Dual Worm wheel, for example, cycle times can be pushed faster while maintaining the mirror finish that customers are looking for. With the new TQX and Quantum Prime grain



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technologies, Norton is able to achieve high material removal rates. These new technologies combined with the knowledge and support from grinding experts, allows Norton to help customers convert from traditional methods of gear shaping (such as milling and hobbing) to grinding from solid, which has significant economic benefits on both tooling spend (cost) and equipment requirements.

To increase diamond dressing roll life, customers require open porosity, easier to dress bond systems and grain technology that requires less frequent dressing. Quantum Prime/Vit CBN can improve diamond dressing roll life. In addition, gear manufacturers and end users are continuously working to improve the efficiency and life of gearboxes.

Many are also working to reduce the noise generated from the gearbox. These goals are driving advances in gear form tolerances and target surface finishes to be even tighter. To address the stricter form deviation requirements, ffa, Norton offers abrasive grinding products that can maintain strong form holding, while achieving productivity goals. When gear makers are targeting a finer than standard finish, different types of Norton Dual grit products are specifically designed to quickly rough grind out the stock material and leave the desired surface finish with a finish grind, according to Fairley.

Cycle times can be pushed faster with Norton's Dual Worm wheel technology. Here's a quick rundown of some of Norton | Saint-Gobain Abrasives latest product innovations:

Continuous Generation – high speed, dual grit

The worm wheels are made in Worcester, MA and have speed capabilities up to 80 m/s.

Quantum Prime is a new, proprietary, nano-crystalline ceramic grain from Norton | Saint-Gobain Abrasives. Due to its unique micro-fracturing properties, Quantum Prime delivers excellent grinding efficiency, significantly longer wheel life, while ensuring outstanding part quality. In addition, TQ is the newest

elongated ceramic grain in the industry, optimized to achieve the highest material removal rates and coolest cut. TQ technology is offered in the fastest worm wheel on the market, which also reduces power draw, increases parts per dress and form holding.

“Continuous Generation Dual wheel technology enables manufacturers to reach finer surface finishes. It combines a bonded vitrified section to grind and a fine grit section to super-finish the gear teeth. This is a new solution from Norton designed to provide stronger transmissions in trucks and quieter gear reducers in electric vehicles due to the extremely fine surface finish it provides. We developed the polishing section in hard resin where the elasticity of the resin is controlled to make sure there is no expansion of the resin during grinding. This results in no deformation of the gear and provides a high level of consistency in surface quality to achieve a mirror finish on the polished gear,” said Fairley.

“We have also made smaller diameter worm wheels available worldwide. These worm wheels are able to grind gears directly on the shaft or countershaft, avoiding the need for welding. The wheels will also allow gear makers to transition discontinuous generation operations to a continuous generation process, greatly increasing productivity,” added Biro.

Profile – TQ/TQX from solid, Quantum Prime grain for form holding & cycle times

With the new TQX grain technology, fast grind cycles are achievable. When there is a significant amount of overstock that needs to be removed from the gear, or if the gear manufacturer is grinding gears from a solid blank, TQX is the ideal solution. This is the newest and longest shaped ceramic grain available, exclusive to Norton.

“When form holding, surface finish,



and overall gear quality are more critical while still requiring higher removal rates, our Quantum Prime grain technology combined with Vortex grain and Vitrium3 bond provides the most cost-effective solution. Quantum Prime provides unparalleled sharpness and cutting efficiency because of unique micro-fracturing properties. This allows for increased MRR and faster overall cycle times. The free cutting grain also breaks down more consistently, leading to improved part quality, geometry, and better surface finishes even at high MRRs,” Fairley said.

As the transition to hybrids and electric vehicles moves forward, the demand for noise level reductions will increase.

“This will lead to tighter tolerance and surface finish requirements throughout the industry. Norton will continue to develop products that meet these tighter tolerances as well as maintain productivity goals,” Fairley said.

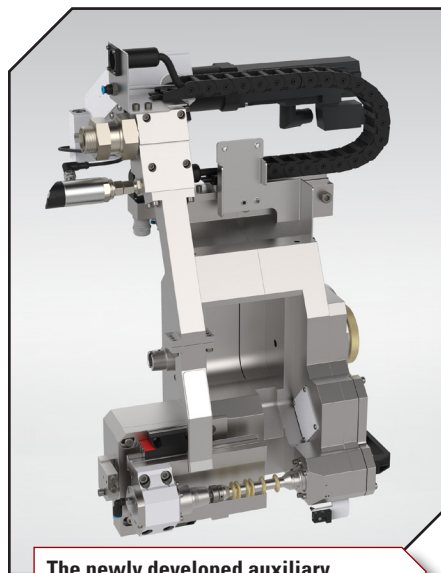
“There will also be vehicles that will transition to electric at a slower pace, such as large commercial trucks and agriculture equipment,” said Biro. “Gear manufacturers will be more focused on increasing the fuel efficiency and overall life of those gearboxes. We anticipate more widespread adoption of the dual grit technology as a solution.”

www.nortonabrasives.com

Flexibility in Aerospace Applications with Liebherr

The machining of gears with interfering contours for the aerospace industry places the highest demands on the grinding tool and often cannot be carried out with standard grinding heads due to the small tool diameters. Liebherr has developed an auxiliary spindle for these applications which can be retrofitted. This enables the production of challenging aerospace components on existing LGG gear grinding machines. They recently discussed this innovation during Liebherr's Performance Days 2021.

The greatest possible flexibility, even for special applications, by means of simple conversion or retrofitting of the necessary tools: Liebherr has been successfully pursuing this approach for several years with its adaptable internal grinding arms. With the existing range of internal grinding arms, a machine can be converted from external grinding to profile grinding of internal gears in a short time. Why shouldn't this proven concept also work for the external grinding of special aerospace components? Following this thought, Liebherr developed an auxiliary spindle as an optional accessory that can be offered for LGG gear and profile grinding machines and can be retrofitted to existing machines.



The newly developed auxiliary spindle is part of a machine purchase that was recently handed over to Liebherr-Aerospace Lindenberg GmbH.



With the auxiliary spindle, the user can use the Liebherr LGG gear grinding machine to produce aerospace components with interference contours.

“We view our standard products as the basis for flexible solutions that are always geared to our customers and their requirements,” says Thomas Breith, head of product management gear cutting machines at Liebherr.

The newly developed auxiliary spindle is part of a machine purchase that was recently handed over to Liebherr-Aerospace Lindenberg GmbH. This sophisticated new development is designed in close cooperation with the user so that the practical needs of machine operators can be incorporated into the design at an early stage. This applies to setup procedures and service tasks, in particular. A typical aerospace application is profile grinding of what is known as a 3-stage planetary gear, which is required for the wing flap adjustment. Due to the weight-optimized, compact component geometry, only small CBN grinding wheels are technically possible for final hard gear finishing.

With the auxiliary spindle, the user can use the LGG gear grinding machine to produce aerospace components with interference contours, along with their special technical challenges, in small batch sizes without having to invest in an expensive, possibly under-utilized, special machine. The geometrically demanding components can thus be manufactured with high gear quality and surface quality. This expands the range of LGG grinding applications to include an additional option for critical, very small and high-quality components.

The auxiliary spindle — just like the internal grinding arm — can be mounted on all new Liebherr grinding heads with counter bearings via a changeover interface, which ensures short setup times.

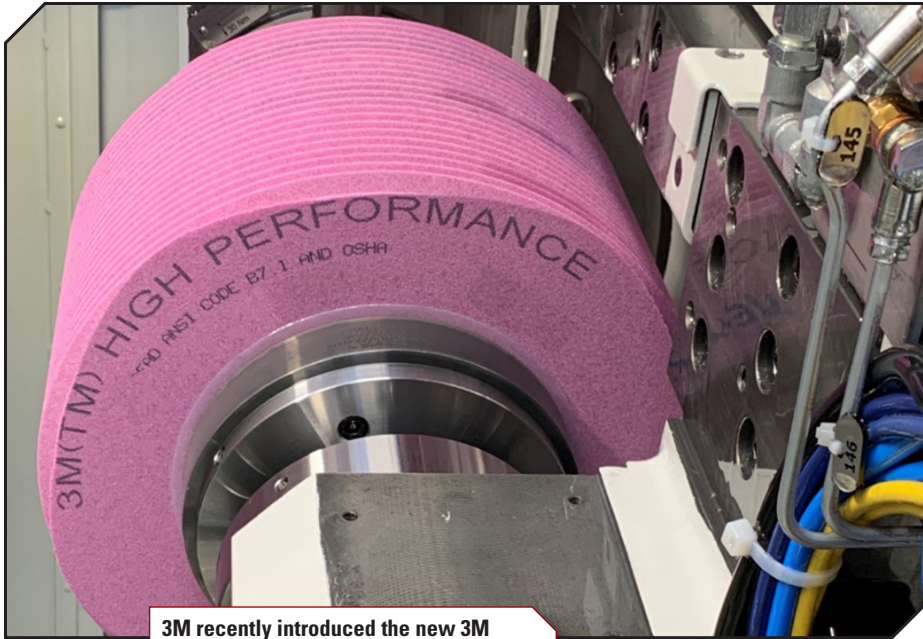
The additional functions of the grinding heads, such as an inductive meshing sensor, a movable cooling lubricant nozzle and a swiveling measuring probe, can also be used in combination with the auxiliary spindle.

Machining parts with very small grinding discs requires high spindle speeds to ensure the required cutting speeds of at least 30 m/s. At speeds of up to 30,000 rpm, the auxiliary spindle must meet the highest requirements in terms of vibration behavior and temperature resistance. A bearing on both sides ensures high rigidity, a stable concentricity and additionally allows the use of a longer grinding arbor, which is the technical prerequisite for the safe mounting of several grinding discs. This enables up to two duo roughing discs and two finishing discs with increased feed rates to be used, significantly reducing machining times.

Liebherr has over 30+ years of CBN expertise. For this reason, a sophisticated development project was started for the extremely small CBN profile grinding discs, in order to galvanize the extremely fine CBN grains (grain size ~25–35 μm) onto the high-precision main bodies, so that the narrow gear tolerances and high surface qualities can be ensured with the finest CBN coatings.

“Liebherr aims to be able to supply all the key components from a single source in order to offer customers the best possible solution in gear grinding machines with accessories, technological expertise as well as tool design and production,” according to Breith.

www.liebherr.com



3M recently introduced the new 3M High Performance 91VX Nano+ Series.

3M Expands and Diversifies Gear Grinding Portfolio

Gear grinding requires high precision throughout the process, and it is important to use the right grinding wheel for the application. The selection of abrasive material and wheel configuration depends on the base alloy, tooth geometry, and size of the production run, among other factors. 3M's recently expanded abrasives portfolio can help you meet the growing demand for tighter dimensional tolerances and shorter production schedules, even with difficult-to-grind materials.

"We have innovated and extended the diversity of our gear grinding portfolio for the new challenges in the changing automotive (special focus on e-Drives) as well as the wind power industry (off-shore)," said Juergen Hechler, global application engineering leader, transportation at 3M Abrasive Systems. "Our customers will be served with the perfect product for their specific situation. We have introduced, for example, a new innovative solution for achieving much higher surface roughness without significant performance redundancies. This is possible with the 3M 91VX Nano 2.0 Series featured by a newly developed bond system that allows us to reduce the amount of unloved bond volume. Less

bond with higher grain retention force, higher abrasive content and more flexibility in the design of the pore spaces for cooler grinding, higher cutting performance, longer lifetime of the grinding wheel and dressing tool and the highest possible process stability and quality in terms of geometry and surface quality."


For achieving high surface roughness with the need to achieve the maximum of performance at the same time, 3M has introduced the new 3M High Performance 91VX Nano+ Series where this newly developed bond systems meets 3M Precision-Shaped Grain with a "plus" of performance.

"The requirements of the automotive industry of the future were the basis for the development of our Nano 2.0 series," Hechler said. "That means increased requirements for profile accuracy and surface quality, grinding of asymmetrical gears with different engagement ratios of the grinding wheels and topologically correct gear grinding. All of this without taking into account the process costs by reducing the cost per part of the abrasives and dressing rollers by significantly increasing the lifetime."

The increasing requirements with simultaneous cost pressure are an enormous challenge for our customers, according to Hechler. "The processes

are of the highest level. Be this in terms of the quality of the components to be ground, but also in terms of process time and tool life. We are constantly busy designing our customers' processes to be even more efficient."

Hechler believes the gear market is in the middle of complex changes.

"Smaller machine series are becoming the rule," he said. "There are more complex controls for even more complex machining processes. You need a higher degree of process monitoring far beyond pure geometry control. The entire process chain is evolving from incoming inspection of the gears, process monitoring of the dressing and grinding process, to the monitoring and evaluation of all axis movements of the machine including the assignment to each individual component. The first gears are already marked with QR codes from which this entire process chain can be documented and analyzed." 

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