

The Comprehensive Gear Grind

Samputensili Develops Alternatives to Conventional Gear Manufacturing Solutions

Matthew Jaster, Senior Editor

Looking for some simple yet useful advice heading into IMTS 2016? Never second guess your machine tool investment. Flexibility is a mandatory requirement in gear manufacturing today. Accuracy, reliability and efficiency must improve with each new machine tool purchase. Innovation is always the end game. So it comes as no surprise that IMTS 2016 attendees will have plenty of gear grinding technologies to consider this fall.

“There has been an increasing demand for noise reduction as nine and 10-speed automatic transmissions have become the norm,” said Enrico Landi, CEO of Samputensili. “Gear manufacturers are challenged to develop new technologies to handle higher speed transmissions, noise reduction and provide solutions that meet all customer requirements while keeping production costs in mind.”

Samputensili recently shared some of its machine tool innovations including the new SG 160 Sky Grind and the GP 500 HL (a combined machine allowing the user to grind on a long shaft, and in one set-up, a spline or gear, the OD diameters, and the related shoulders) with *Gear Technology* as well as a run-



Double work spindles, driven by linear motors, make it possible to obtain a fast workpiece change and a chip-to-chip time under two seconds.

down of the machines available today through Star SU in the U.S. grinding market.

Manufacturing Challenge Accepted

How are the latest gear grinding machines solving the manufacturing challenges that occur on today's shop floor? Samputensili is focused on a few key areas according to Roberto Bagni, product manager. “The main features for customers investing in the grinding process include the improved quality of ‘silent’ gears, a reduction in cycle times, a precise and flexible dressing unit for profiling the grinding worm wheel, a user-friendly and safe HMI and a total savings on investment, consumables, tools and energy.”

Noise reduction

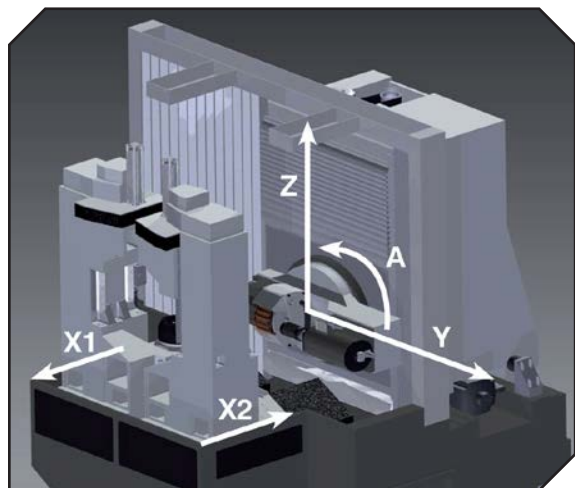
Bagni said that extremely high accuracies are the norm

for today's hard-finishing technology. “There are several other aspects that help to improve noise characteristics including topological grinding, superfinishing and surface topography.”

With topological grinding, the idea is to apply specific modifications to the grinding wheel in order to compensate the natural twist effect and to obtain the desired profile and lead.

Superfinishing divides the grinding wheel in two sections: grinding and polishing. In the grinding area, a standard ceramic bond is used for the roughing and finishing process. In the polishing area, a resinoid bond is used for the superfinishing operation. Roughness even below 0.1 Ra is achievable with this process.

Surface topography controls the surface pattern generated on the teeth during grinding, through the definition of proper dressing and working parameter, in order to avoid the generation of any malicious resonances that could negatively affect the noise level.



The G 160 is an innovative, patent-pending machine featuring a very stiff and unique architecture and only three stacking axis (Y, Z, A) granting the highest dynamic stiffness and a new virtual Y-axis.



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Decreasing cycle times

In the last decade, the grinding cycle time has decreased significantly. "This drastic reduction is due to the new machine features which make it possible to reach a much higher cutting speed (from "old" 35 m/sec to the present, and also higher forecasted in the near future, 80 m/sec) and dress the worm wheel with a practically unlimited number of starts," Bagni said. "Another important role has to be attributed to increas-

ing the coolant pressure up to 250 and more psi solving the problem of cleaning the grinding wheel faster, consequently granting a longer wheel life," he added.

Reducing idle time out of the grinding process

The goal of global machine tool manufacturers is to offer machines where the non-productive idle times are minimized. For example, dual work spindles are utilized to reduce part changeover

time including alignment. "The dressing tool axis is located as close as possible to the working position. This not only grants a precise wheel calibration, but it also drastically reduces the dressing time," Bagni said.

The flexibility to use the same machine for various part sizes

Samputensili grinders are ergonomically designed to allow ease of workpiece changeover. These grinders also have the ability to do gears and shafts on the same machine with easy changeover. As for tailstock set-up, Star SU provides a fitting taper morse-type while the clamping force can be changed and stored in the part program through the CNC. The use of quick-change tooling can save considerable changeover time.

Machine Considerations

So how are some of these grinding advancements applied to Samputensili's equipment? Through its relationship with Star SU, there are at least four machines available for the U.S. grinding market including the G 160, SG 160, GP 500 HL and the GW 3600 H.

G 160 "Wet Grind Version"

A new concept for high-productive grinding of gears up to 160 mm diameter with double work spindles, where



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Two-Axis Servo/Rate Rotary System

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Astro Guidance Test Platform

References the north star three axis (Ultralex) index system. System accuracy 0.3 arc second band, PC based control, IEEE-488 interface.



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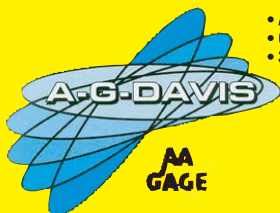
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Skive-hobbing did not succeed in producing transmission gears because the cutting edges created by the hob form a regular pattern (feed and profile scallops) on the gear flank. This is unacceptable as for durability and noise (left). This is one of the reasons why grinding has become almost mandatory as a finishing process. The smooth but irregular surface grants a high load capability, high durability, and quiet running (right).

separate X1 and X2 axes (driven by linear motors) replace the rotary turret and make it possible to obtain a fast work-piece change and a chip-to-chip time under two seconds.

The G 160 features a very stiff and unique architecture and only three stacking axes: Y, Z, A granting the highest dynamic stiffness and a new virtual Y-axis. It allows high thermal and

mechanical stability due to the free swarf disposal area located underneath the machining area and to the transversal chute for oil and swarf return. No additional axis is needed to perform the dressing cycle. The dresser is mounted on the X1 axis slide for minimized inter-axis errors. An acoustic emission sensor is offered for easy setup and multi-rib dressing capability.



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SG 160 "Sky Grind"

The same concept as the G 160 is the SG 160 with a brand new, highly sophisticated dry-hard-finishing, better known as sky-grinding. "For decades in the transmission industry, the gear manufacturing process, starting from the raw material, has required the following steps: 1) soft-turning, 2) soft-hobbing the gear teeth, 3) deburring, 4) hardening, 5) hard-turning and lastly, grinding the gear teeth," Landi said. "The reasons why gear grinding has been expensive so far, is not just because of machinery and tooling costs. A major contributor to cost increase is the use of oil as a coolant in the process."

Aside from the production cost, the oil creates costs throughout its life cycle, starting with huge additional investments for the extra installation in and around the machine, automation to catch and gather dripping oil from components and the necessary handling systems and equipment to return the oil into the coolant circuit.

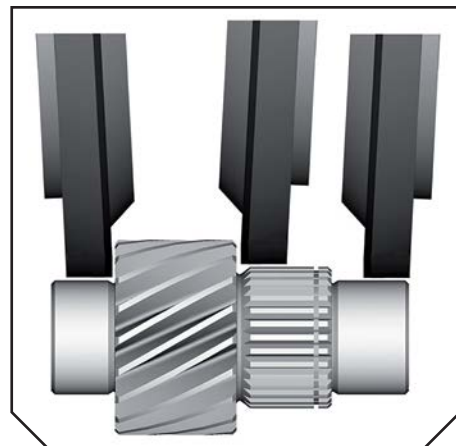
"All of these units consume valuable space," Landi said. "A typical installation

for gear grinding requires less than half the footprint necessary for the grinding machine itself. Much more room is used for installation of all the additional equipment around."

Grinding automotive transmission gears are mostly done in two steps: roughing and finishing. During roughing, around 80 percent of the total material is removed and the gear flanks are cleaned by finishing. On the other hand, technologies exist that can remove a high amount of hardened material without any oil and without heat on the workpiece surface.

Hard turning is one example, and it has become a state-of-the-art in the bearing manufacturing industry. In gear production, hobbing of hardened gears with carbide tools (or skive-hobbing) is currently used without oil, even in mass production. Steering pinions are a typical application.

The logical next step was to combine the removal rate of the dry skive-hobbing with the geometric accuracy and surface quality of the dry finish grinding process. Samputensili has addressed this



Samputensili has introduced a fully automatic grinding wheel changing system complete with a grinding wheels magazine up to five stations.

challenge by not only developing this dual technology but also by creating the SG 160, to run this process for automotive mass production.

GP 500 HL

Star SU, following up the strong demand for implementation of the OD grinding process, has made a decision to introduce the possibility to grind on the same shaft, and in same set-up, also the exter-

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nal diameters and the related shoulders as well with the GP 500 HL.

On the two spindles, now dedicated each to a different operation, are two grinding wheels, one for the toothed part of the job, and the other for the external grinding. Spindle variants with different power outputs and speeds are offered for different manufacturing tasks (ceramic or CBN), fast format changes via quick-change adapters and modular software. The machine can be supplied with an in-process Marposs control for both diameters and shoulders.

The wheel could be slightly angularly positioned and dressed to achieve a better finishing, while grinding both diameter and shoulders on one side of

the shaft. "The big advantage is that the Samputensili wheel head can be rotated 180 degrees upwards thus allowing the same side of the wheel to grind both shoulders, on the right or on the left flank, and the head rotation takes only few seconds," Bagni said.

This combined machine could be the right solution for many job shops, specializing in grinding technology, giving them the possibility to completely finish the part after heat treatment. "This achieves a real cost reduction by having less machines involved in the final production process while reaching a superior quality level," Bagni added.

GW3600 H "Wheel Magazine"

The GW 3600 H thread grinding machine is able to grind plastic extrusion screws, as well as any other type of screw, from solid, with a total length up to 3,000 mm. Built with the same concept of stiffness, precision and high rigidity common of all the smaller size Samputensili machines, this grinder includes: an oversized 35 kW motor spindle complete with a wheel automatic balancing unit, a Heidenhain direct measuring system for radial and axial movement on high precision linear guides with pre-loaded roller cages, a fixed steady rest, self-centering, three points, hydraulically-operated for automatic movement, with high accuracy





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The GW 3600 includes an oversized motor spindle (35 kW), complete with a wheel automatic balancing unit integrated in the main spindle body, located in the machine column with axial and radial movement.


and repeatability down to 3 μ m or an innovative migrating steady rest, moving on dedicated linear guides, that could follow the dressing wheel motion from the opposite site of the part.

In addition, the HMI includes a wide range of different processes carried out thanks to specific and reliable software able to perform variable pitch, taper and barrier screws in all possible configurations. "Up to now, the only possible limitation was the need to change the grind-

ing wheel according to a completely different shape of the workpiece," Bagni said. "Samputensili has introduced a fully automatic grinding wheel changing system complete with a grinding wheel magazine offering up to five stations."

Next Stop IMTS 2016

The positive feedback received on these grinding concepts like combination machine technology and sky grinding provides a new way of thinking about

machine tool purchasing decisions, according to Landi. "This confirms that these new processes will transform the production of transmission gears in the long run." 

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