

Holroyd Launches New Gear Grinder

New machine promises DIN2 accuracy and unique features at a low cost

Holroyd, long known for its expertise in creating machine tools for manufacturing rotors and other helical components, has now applied that expertise to the manufacture of gear grinding machines with the October 2004 launch of the GTG2, a machine tool specifically designed for small- to medium-batch production of high precision helical gears.

“Our design aim was to produce the lowest cost, highest accuracy grinding machine for helical and worm gears in the world,” says Dr. Tony Bannan, Holroyd’s engineering director, who led the design and manufacturing team that developed the machine.

The GTG2 has all the features of a modern gear grinding machine—including on-board inspection and grinding wheel dressing. But it also comes with some uncommon features that stem from Holroyd’s experience with helical components *other* than gears.

“We’ve approached the development of gear grinding from a rather different angle, which we think has led to many strengths,” says Dr. Chris Holmes, Holroyd’s R&D director.

One of the GTG2’s uncommon features is its approach to topological modifications of the gear teeth. The Holroyd method, say its developers, solves the problem of flank twist on helical gears. Many older models of form gear grinding machines use a method called “bob crowning,” which varies the depth of the grinding wheel in order to achieve tooth



modifications.

“When you do bob crowning, you get a distortion of the gear,” says Alan Stephen, special projects manager for Holroyd. “This is unavoidable, because of the way you’re generating the shape. It’s correct in the middle, but not near the ends.”

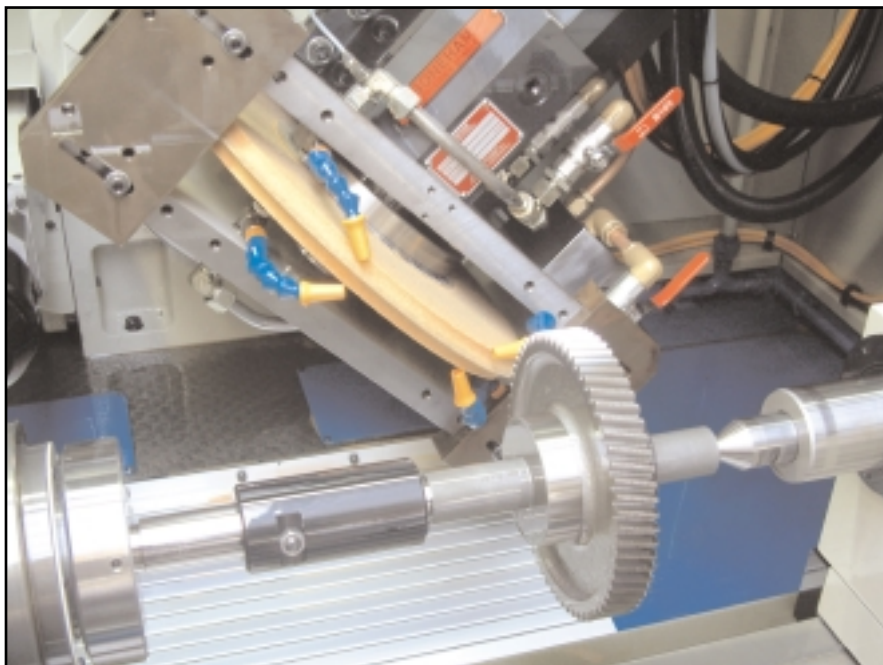
Helical twist causes the profile of the tooth to vary across the face. In many applications, this “error” is not of concern, but in high precision and low noise applications, it affects gear performance by concentrating loads on particular areas of the teeth during meshing. “You may actually want the gear to have this kind of relief,” Stephen says, “but the problem is, you can’t control it. It depends on the wheel diameter, and you



get what you get. Our object was to make an improvement on this.”

Holroyd’s improvement was to apply a different kind of motion to the grinding pass. Instead of the workhead depth, the GTG2 varies the workhead’s swivel angle in order to achieve crowning. This method is patent-pending.

“What we do is, as we’re grinding through the gear, the grinding head will



Holroyd's New GTG2 Gear Grinder promises DIN2 accuracy and unique features at a low cost

actually noticeably alter its angle of swivel as it passes through the gear," says Paul Hannah, Holroyd's VP of global sales and marketing. But varying the swivel angle alone isn't enough to solve the problem entirely, Hannah says.

The GTG2 also comes with a built-in simulation package, which allows the machine to simulate the actual cut, assess any inaccuracies, and make adjustments to the grinding wheel. "We then correct the wheel," Hannah says, "making the

wheel wrong, if you want, to make the gear right."

The mechanical motion, the simulation package and on-board inspection combine to create a closed-loop feedback system, which enables this machine to provide the highest levels of accuracies, Hannah says. "After we've ground the first one, we measure it, feed back and correct all over again. So instead of something that becomes an approximation of a target profile, we're actually creating the

target profile that the designer has wanted. That's something which, I believe, is quite innovative in the field of gear manufacturing."

The on-board inspection is accomplished through the use of a Renishaw CMM probe. "This Renishaw scanning probe that we use on our machine is a full 3-D scanning probe," says Holmes. "It's not a touch-trigger probe. It's the sort of scanning probe that you would have on a full, high-accuracy CMM. The deflection in each of the three directions is measured. It can measure deflections of two microns."

The development of the technology associated with the GTG2 has resulted in Holroyd receiving the British Queen's Award for Enterprise 2004, in the category of innovation. "We are delighted that the awards committee has recognized the ingenuity of our designers, their hard work and effort," says Hannah.

Some of the machine's development was carried out at the Design Unit at the University of Newcastle upon Tyne. "We looked for what we felt was the strongest gear development center in Europe," Hannah says. "We found it very useful that one of the top gear development centers in Europe is the Design Unit at the University of Newcastle, so we forged strong links with Professor Dieter Hofmann of the Newcastle gear design center. We worked with him and his students—we put some of our guys working with them—and they also worked with us at our facility, sharing a lot of knowledge that developed the first machine. The first one went into Newcastle. Then we continued adding on after that."

The first GTG2 machine for production has been sold to Micro Precision Ltd., a Hemel Hempstead, U.K., manufacturer of precision components for the aerospace, medical and Formula 1 industries. "We're still going through a learning curve with the machine," says Barry Cave, director at Micro Precision, "but we are extremely satisfied with it. In our brief experience with it, it is holding very close tolerances."





Holroyd developed its own software and controls for the GTG2.

In some cases, under optimum conditions, those tolerances are being held to DIN 1 levels for some measurements, Cave says. He also notes that "on some components, our set-up times have been reduced from three days to three hours. In addition, we now also have the flexibility to quickly change gear forms to meet our customers' requests."

The staff of Micro Precision had plenty of experience with the GTG2 before making their purchase, says Hannah. "We actually took them into the Newcastle design center. They started to produce their gears on our machine at Newcastle before they actually bought the machine."

Micro Precision also conducted machine trials at Holroyd before making their purchase, Cave says.

According to Hannah, allowing the customer to try the machine out is normal operating procedure for Holroyd. "We recognize that we have a high profile in the rotor industry, but in the gear industry, whatever our history was, we're the new kid on the block now. So we're willing to come to people like this and say, 'What do you need from us? We'll prove it to you. Don't take the risk. We'll happily put our money where our mouth is. I'm not talking about a quick demonstration. Let's make a batch of gears, let's make 10 batches of gears. You can, in fact, send your own operator to work the machine in our plant or some other place to make the gears on it. Then you can make your decision.'"

To make that decision easier, Hannah says, the price of the GTG2 will compare

very well with competitive machines. "We designed this machine the way we design all machines now, looking at a design for cost. And, in doing that, we set ourselves aggressive cost targets. We're well within those cost targets, and we have a product which is very aggressively priced in the gear industry."

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Robust Transmission Design through Automated Optimization of Virtual Prototypes

Romax Technology, the U.K.-based supplier of virtual transmission simulation software and technical consultancy services, is automating the design iteration optimization process to allow companies to be faster to market with the highest quality, most robust geared products.

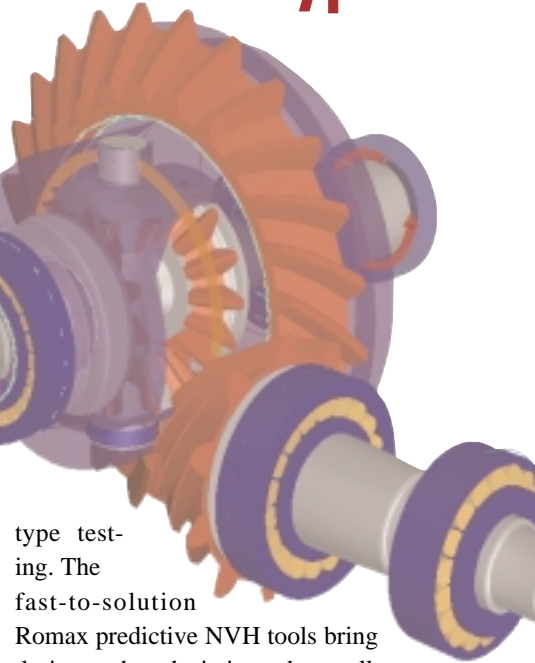
"RomaxDesigner has the closed-loop analytical techniques required for the addition of optimization algorithms to enable the software to search the entire design space for the optimal 'right first time' solution," says Dr. Peter Poon, managing director. "Romax can run hundreds of simulated tests, reducing the need for costly prototype hardware and lengthy, expensive development test programs."

Romax offers a suite of fully integrated software modules for the durability and NVH dynamic analysis of all types of parallel shaft, planetary and perpendicular

axle power transmission systems to ISO and AGMA standards. Global customers are supported by teams of software developers and technical specialists to smooth the implementation of Romax into organizations.

According to Poon, the simulation models accurately predict all the system deflections under all loading conditions that have an influence on gear mesh misalignment. Automated optimization of the macro- and micro-geometry of spur and helical gears maximizes durability, improves smoothness of operation to reduce gear noise, and reduces the effect of manufacturing tolerances on transmission error.

The software is used in the automotive and construction industries for the design of manual, parallel-shaft transmissions.



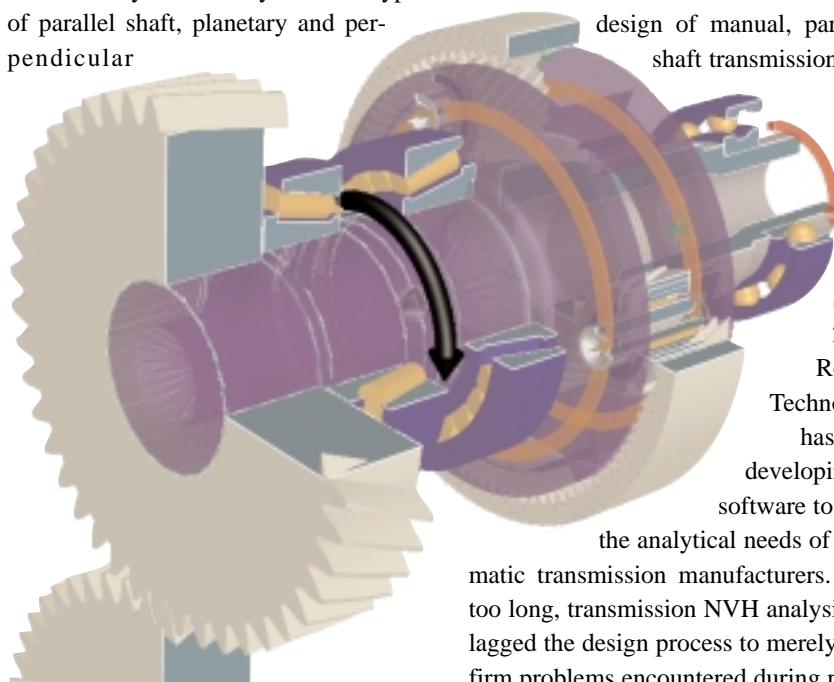
type testing. The fast-to-solution

Romax predictive NVH tools bring design and analysis into phase, allowing analytical engineers to have an influence on the design before hardware is made," says Simon Roberts, business development manager for the North American market. "The extension of the NVH analysis to improve the torque density and reduce gear whine in planetary transmissions has opened a whole new market for us."

The Romax Approach

Traditional finite element (FE) models of transmissions require the combination of measured test results with analytical techniques to understand system dynamics. The models are large, time consuming to build and modify, and require "fudge factors" to correlate the predicted results with measured data before modifications can be made to improve system NVH characteristics.

RomaxDesigner analysis models include the lateral, axial and torsional degrees of freedom to accurately predict



Since 2001, Romax Technology has been developing its software to meet

the analytical needs of automatic transmission manufacturers. "For too long, transmission NVH analysis has lagged the design process to merely confirm problems encountered during proto-

the dynamic behavior of the internal components at the design stage without the need for measured data, Roberts says. The dynamic characteristics can then be used to identify any potential gear whine problems. Modifications to the gear micro-geometry and component dynamic characteristics, to minimize transmission error excitation and reduce system responses, can be implemented to optimize transmission NVH levels far in advance of hardware manufacture and test.

The development of such complex virtual simulation software requires close interaction between software developers and experienced transmission design and analysis engineers, Roberts says. In addition to developing the software, this in-house engineering capability also allows Romax to offer comprehensive consultancy services from "find and fix" projects eliminating durability and NVH issues to full turnkey transmission design projects.

"As a company, Romax Technology is committed to enabling transmission design and manufacturing companies to achieve 'right first time' designs," says Poon, "eliminating the risk of encountering problems during development testing, reducing the need for verification testing, shortening the time to market, and minimizing the piece cost of the final product."

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"RomaxDesigner has the closed-loop analytical techniques required for the addition of optimization algorithms to enable the software to search the entire design space for the optimal 'right first time' solution," says Dr. Peter Poon, Romax Technology's managing director.



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A Planetary System that Increases Power Density



More power at your fingertips—Turnkey Design Services is manufacturing a planetary gear system to increase power density.

A gear buyer has a motor, an actuator and a new requirement for the gears between them: More power in the same space. Or he may face the other common requirement: The same power in less space. Whichever is the case, he needs a planetary gear set that will do the trick in his low horsepower application.

Also, whichever is the case, he may find the needed gear set in a design conceived by the National Aeronautics and Space Administration and developed by it and Turnkey Design Services LLC, a small engineering firm.

As an example of more power in the same space, TDS compares its planetary set to a similar, conventional set. Both have gearhead diameters of 23 mm. The TDS set has a reduction ratio of 222:1, the other a ratio of 246:1. The TDS set, however, can sustain a maximum torque of 1.2 Nm to the other set's 0.7—that's a 71% increase in maximum continuous torque.

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Moreover, the TDS set does its work in two stages; the other set uses four. Not surprisingly, the TDS set weighs less than its counterpart, 35 grams compared to 100.

The greater power and fewer parts—and the consequent reduced weight—result from the planetary set's design. The heart of that design is the elimination of a separate bearing and the incorporating of a cylindrical roller on the sun gear and each planetary gear. These rollers provide the same function as a bearing would. They also allow the TDS set to achieve greater load sharing between its gears, thereby increasing load carrying capacity, says president & engineering manager Rob Kennedy.

He adds that the gear-bearing product can achieve several gear ratios in the same space by swapping out several gears. These ratios include 3.8:1, 28:1, 43:1 and 1,298:1. TDS is already in the midst of proving this ability to a Chicago manufacturer of electric gear motors.

TDS is manufacturing three prototype sets, each with the same diametral and axial envelopes, 3" and 2.6" respectively, but each with a different ratio, 38:1, 55:1 and 346:1. Based on TDS's detailed drawings, these ratios can be achieved by replacing the first stage gears (sun, planets and ring) without replacing the second stage ones, Kennedy says.

TDS is looking to use the planetary set for speed reducing in conjunction with electric and hydraulic motors that drive actuators, pumps, compressors and gearboxes.

Kennedy says TDS intends to market the gear-bearing product to the automotive and aerospace industries and describes several possible applications in both industries. The planetary set could be used to open and close sliding doors on vans, to open and close lift gates on SUVs and to move power seats back and forth in automobiles. In aerospace, the assembly could be used to open and close bay doors of cargo and fighter aircraft and to extend and retract aircraft wing flaps.

NASA conceived and initially developed the gear-bearing product and later licensed TDS to look into its commercial uses and to manufacture it. TDS itself is a custom-product design firm that specializes in hydraulic and pneumatic products and applications and in turbo-machinery.

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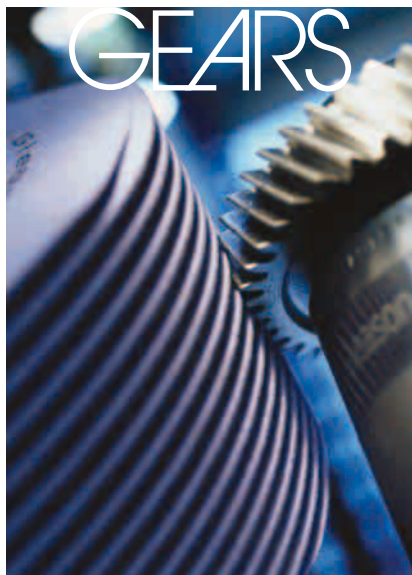
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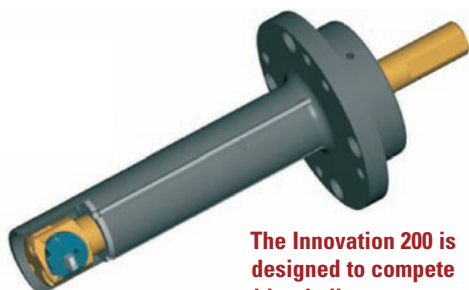
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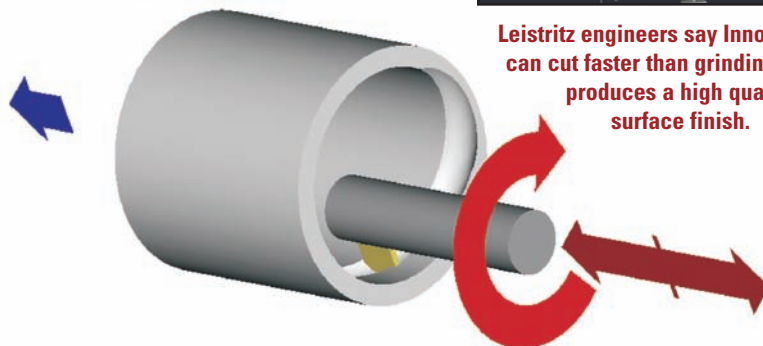
New Internal Whirling Process from Leistriz



The Innovation 200 is designed to compete with grinding processes for the manufacture of internal threads.



Leistriz engineers say Innovation 200 can cut faster than grinding but still produces a high quality surface finish.



Leistriz Corp., of Allendale, NJ, has developed the Innovation 200 internal whirling process for machining difficult internal threads. Performed without coolants, internal whirling is compatible with either soft material or steel as hard as 65 HRC using carbide tooling.

Engineers at Leistriz saw the need for a process that did not involve the high spindle speeds associated with grinding, which can require speeds in excess of 30,000 rpm. In addition to this, the complications of distributing the coolant to the exact interface between the workpiece and the grinding wheel add more difficulty to the grinding of internal threads. Finally, the grinding wheel must be dressed with a compensated contour to generate an acceptable thread profile.

"Innovation 200 does not require a coolant," says Ralph Wehmann, sales

manager at Leistriz. "Number two, we don't need such a high spindle speed."

This machine is an inverted vertical machine with the chuck on top. The "z" axis longitudinal travel moves the chuck and its rotary "c" axis up and down. The head remains stationary.

One of the key advantages of this design is that it isolates vibration caused by the oscillating masses directly into the massive machine bed. The bed is very dense with different vibration absorption characteristics. Hydrostatic guideways for all axes guarantee high precision and accuracies.

Integrating automatic loading is easier because the chuck remains above the work, and the combined "x" and "z" axes have expanded travel areas. Therefore, the chuck can act as its own gripper system and go to a familiar location to pick up a blank workpiece.



Sample parts made by internal whirling.

Probes can be used to obtain the true position of timing holes, so the thread can be precisely timed for the start point. It is also possible to hard turn the bore prior to whirling.

A 12,000 rpm milling spindle is available for auxiliary operations. As the tool rotates at cutting speeds of approximately 600 sfm, it also oscillates axially. The amount of oscillation is calculated from the thread parameters and tooling circle data. Higher lead threads require larger oscillation amounts, and the oscillation continually maintains the cutting insert normal to the helix angle. According to the company's press release, a completed thread is achieved in a single whirling process.

"Really, the most unique thing is that as it turns, it cuts in and at the angle," Wehmann says, "When it's not cutting, it oscillates back so that each revolution it moves up and down. On a half turn, it oscillates in and the other half oscillates out within a single revolution. The oscillation amount is programmable."

As far as the quality of the finished product, Wehman says it's as good as grinding for every dimension, and it can cut faster with high-quality surface finish.

Wehmann estimates that the Innovation 200 is comparable price-wise to grinding, with price tags at about \$600,000–\$700,000 for the complete machine. However, with threading, there is no danger of additional costs for coolant or filtration systems, he says.

Innovation 200 is designed for ball screws, acme nuts, rope or other threads and power generation. Berger Precision,

a ball screw company in Germany, has already tried this concept to produce an automotive component with a 6 lead thread used in a light truck to control automatic vehicle leveling.

"That machine was one of the first delivered in August. It's been running with no problems since then," Wehmann says.

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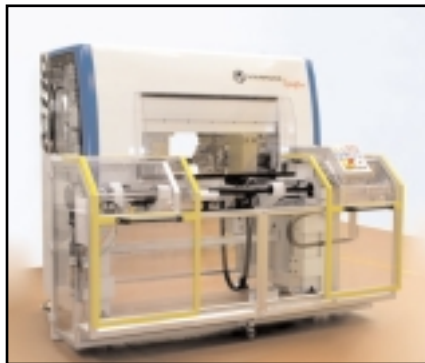
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New Measuring Machine from Marposs



The M110 Optoflex from Marposs is designed for the dimensional inspection of shafts and shaft-like parts. Utilizing optoelectric technology, this machine can inspect a number of parts while performing different types of measurements.

Designed for use in a shop floor environment, the machine can be integrated into a product line with the possibility of feedback to the machine tool. It can also be used as an audit station or for post-process inspection applications.

According to the company's press release, the machine offers a high degree of flexibility by using shadow cast optoelectronic solutions. As opposed to the traditional contact and air-to-electric solutions, this method allows measurements to be performed without touching the part.

A single light blade produces measurements and an LVDT probe can be incorporated for axial TIR measurements. Performance checks include static and dynamic diameters, stroke and index, straightness and profile analysis.

For more information, contact Marposs Corp. of Auburn Hills, MI, by telephone at (248) 370-0404 or on the Internet at www.marposs.com.

New Grinder from United Grinding

The new S33 universal cylindrical grinder from United Grinding can grind longer shaft-type parts due to its 1,000 mm capacity between centers.

According to the company's press release, the machine was designed specifi-

cally for the North American market.

Other features include digital direct drive, V- and flat guideways coated with abrasion-proof Granitan S200 and three-phase servomotors with 40 mm diameter prestressed precision ballscrews that power the X- and Z-axes.

In addition, this machine features Fanuc 21i digital control and axis drive components. The control package has Studer grinding cycles for diameters, shoulders (left and right), tapers (negative and positive) and contours.

For more information, contact United Grinding Technologies of Miamisburg, OH, by telephone at (937) 847-1222 or on the Internet at www.grinding.com.

New Measuring Machine from Mahr Federal



The MarVision from Mahr Federal is designed to provide a mid-sized solution for high precision applications that require multiple modes of inspection.

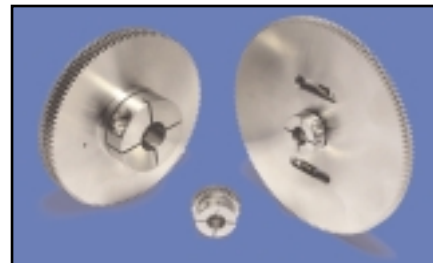
According to the company's press release, this machine is fully automatable and incorporates a CCD camera, TTL laser and mechanical touch-probe sensor to provide precision measurement in a design best suited for use near production line and work cell environments.

The software is available in an open-architecture style that supports use of the GUI for operators. Other features include

a measuring table and crossed axes equipped with precise roller bearings and precision, backlash-free, DC servo drives.

For more information, contact Mahr Federal of Providence, RI, by telephone at (800) 333-4243 or on the Internet at www.mahr.com.

New Instrumentation Gears from Precision Alliance



A new line of specialty and instrumentation gears from Precision Alliance includes spur, segment, anti-backlash synchro, beveled, worm and customized gears.

According to the company's press release, all are rated at AGMA Class 14 and beyond. Available in a variety of standard materials including bronze, aluminum and stainless steel, these gears come with or without hubs.

For more information, contact The Precision Alliance of Fort Mill, SC, by telephone at (803) 396-5544 or on the Internet at www.theprecisionalliance.com.

New Geared Motors from Danfoss Bauer

The BG Series of three-phase geared motors from Danfoss Bauer is engineered to drive a variety of types of machinery and equipment.

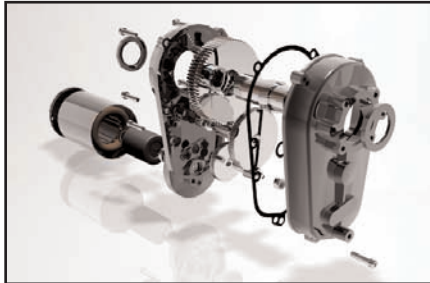
The motors have a power capability of 0.075–50 hp with output speeds of 0.3–540 rpm and a torque range of 177–163,000 lbf.-in. Available as a standard two-stage design, the motors include stator winding of high quality insulated enameled copper wire, an aluminum die-cast cage rotor and gear wheels that are constructed of high tensile and die-cast steel.

According to the company's press

release, the gearbox housing is completely enclosed for operation in harsh conditions and prevents lubricant loss and dirt build-up.

For more information, contact Danfoss Bauer of Somerset, NJ, by telephone at (732) 469-8770 or on the Internet at www.danfoss-bauer.com.

New Bison Gearmotor



The 562 Series hollow-shaft gearmotor from Bison Gear has an increased center distance and greater clearance for wider faced gear shafts.

The 562 offers an optional fourth stage of gear reduction and provides ratios up to 2,200:1 in the same envelope. According to the company's press release, this allows for a smaller input motor without sacrificing output torque.

Featuring hollow shaft options with multiple mounting configurations, this gearmotor is offered with a variety of AC and DC input motors, including three-phase and inverter duty.

For more information, contact Bison Gear of St. Charles, IL, by telephone at (630) 377-4327 or on the Internet at www.bisongear.com.

New DC Gear Motor from Midwest Motion Products



The new MMP.PDSF80-12V.018.1 geared motor from Midwest Motion

New Coated Insert from Seco-Carboly

The TP3000 from Seco Carboly is a new generation of coated inserts for steel turning to be used on machining applications such as heavy roughing, interrupted cuts, heavy feed rates and workpiece materials with uneven machinability between different material batches.

The carbide incorporates a hard coating composed of an alpha alumina material with a fine grain structure. According to the company's press release, the coating's smoothness prevents the built-up edge that can occur in machining stainless materials.

For more information, contact Seco-Carboly of Warren, MI, by telephone at (586) 497-5000 or by e-mail at carboly@carboly.com.



Products can accept VDC power sources, including batteries.

According to the company's press release, the reversible geared motor measures 2.8" in diameter by 5.6" in length with an 80 mm square gearbox. The output shaft is 10 mm in diameter and includes a square shaft key and keyway.

The geared motor has a shaft output speed of 160 rpm and is rated for 26 in.-lbs. of continuous torque at 3.9 amps of current. Popular options with this servomotor include integral optical encoders, fail-safe brakes, analog tachometers and optional ratios from 3:1 to 180:1.

For more information, contact Midwest Motion Products of Watertown, MN, by telephone at (952) 955-2626 or on the Internet at www.midwestmotion.com.

New Compact Gearbox from ZF Industrial

The CG gearboxes from ZF Industrial are best suited for use in robotic or other automation applications, like electronics or other OEM manufacturing industries.

According to the company's press release, these gearboxes feature a back-

lash absorbing system that includes a tapered gear tooth profile optimized for the highest levels of precision. Backlash rates are less than 0.5 arc-min.

In addition, the gearboxes include a large output flange that is supported by oversized cylindrical roller bearings that can produce an assembly with an output torque of up to 2,500 N-m. Acceleration torques of up to 2,500 N-m can be achieved due to an interlocking power transmission design that reduces the gearbox's length and provides efficiency levels up to 94%.

Available in five models with ratios from $i = 20$ to $i = 103$, the units can accept speeds up to 5,300 rpm and maintain sealing levels up to IP65.

For more information, contact ZF Industrial of Nottingham, U.K., by e-mail at rob.pearson@zf-group.co.uk.

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