# Reliable and Efficient Skiving

## Klingelnberg's New Tool and Machine Concept allows for Precise Production

**The new stick blade tool system uses carbide technology which has long been used for bevel gears (All photos courtesy of Klingelnberg).**

Klingelnberg AG presents its latest innovation, skiving. This newly developed tool system can be used on bevel gear milling machines and allows for a productive, stable and precise production process, particularly for internal gears. Despite high productivity and system-inherent accuracy, the breakthrough of skiving has been denied due to the tool problem. The chip formation process in skiving is very complex whereby large negative rake angles and only very small clearance angles arise during the process. The current tools, mostly cylindrical or conical solid carbide cutting wheels, have no degree of freedom for the necessary optimization. In addition to high machining forces, negative cutting angles also consistently lead to excessive wear of the tools meaning that the tool costs per component largely surpass the proportional machine costs. Klingelnberg's newly developed software shows the exact chipping conditions and therefore allows for a targeted optimization of the cutting geometry and the production movement.

The new stick blade tool system uses carbide technology which has long been used for bevel gears. "Skiving itself is in fact an ancient concept. The key innovation hereby lies in the use of stick blades and the resulting design possibilities for the cutting edge—a breakthrough in cutting technology," says Dr. Hartmuth Müller, chief technical officer of Klingelnberg. The stick blade has the distinct advantage of offering optimal cutting geometry through grinding. This is a necessary condition for the optimization of the chip formation process and therefore forms the basis for the breakthrough of skiving. A stick blade tool system also offers a wide range of further advantages including flexibility, optimized cutting geometry and minimal use of carbide metal.

Using the known Oerlikon stick blade grinding machine, the user can cost-effectively produce the tool for their own application within the shortest lead time and guarantees longer tool life than those of a shaping cutter or a skiving tool. In a stick blade tool, carbide is only used for the cutter which therefore ensures a highly efficient use of resources.

The entire process is highly energy-efficient, productive and flexible. In addition to the free design of the tool, tooth flank modifications can also be applied by superimposing additional movements during the skiving process. These advantages in comparison to gear hobbing, gear shaping or broaching are of particular importance for the production of internal gears. A simple comparison of shaping and skiving productivity shows that skiving is up to ten times quicker and offers a significantly longer tool life.

Although skiving is a machining process using a defined cutting edge, the surface qualities achieved are outstanding. Due to the very high fre-

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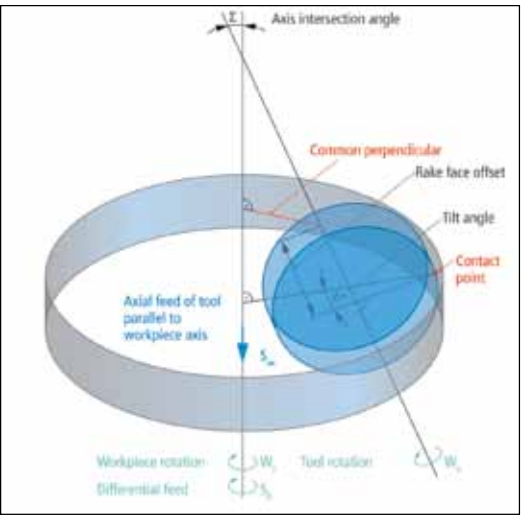
quency with which the cutting edges move across the tooth flanks to be produced, a completely different surface texture is achieved than, for example, that of gear hobbing or shaping. In the image, the movements of two successive cutters in the tooth space are displayed as blue tracks. The distance of these tracks is determined by the axial feed rate with which the tool is moved along the face width of the gear to be produced. The cutting frequency is up to ten times higher than that of gear hobbing. As a result, a finer surface texture is achieved without the hollows created by gear hobbing or the grooves created by shaping and caused by tool wear.

**Skiving can be executed on the Oerlikon C29 and C50 bevel gear milling machines. These machines ensure a highly-precise coupling of all movements which are necessary for skiving.**

The incorporation of all these steps along the process chain to form a continuous data network guarantees stable and secure manufacturing processes. For Klingelnberg this is a trusted and globally approved approach within the scope of the closed loop concept. In order that the user is able to benefit from the same process security for skiving as that for bevel gearing, Klingelnberg has developed the closed loop for skiving which also incorporates tool preparation operations.

Skiving can be executed on the Oerlikon C29 and C50 bevel gear milling machines. These machines ensure a highly-precise coupling of all movements which are necessary for skiving. The highly dynamic process also requires a rigid machine design. The vertical arrangement of the tool and workpiece spindle offers particularly favorable conditions for chip removal. The C29 and C50 machine series meets all conditions required for skiving.




**Skiving is a machining process in order to create periodic structures on rotationally-symmetric parts.**

Skiving is a machining process in order to create periodic structures on rotationally-symmetric parts, for example, involute and non-involute gear teeth and splines for both internal and external components. The periodic structures are created through a generating process. The kinematic basis for this is the crossed axis helical gear. The skiving principle was developed at the beginning of the twentieth century and patented in 1910 by the company Pittler. Based on the target component geometry, a meshing tool is designed having a crossed axis with that of the work piece at a predefined angle. The cutting movement arises from the sliding component in direction of the face width of the teeth of the tool and the gap to be machined. This component is determined by the angle between the crossed axis, the size of the tool and the rotation speed of the producing gear transmission.

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# The Ever-Expanding Spiral Bevel Platform

Expanding market share in the spiral bevel gear segment poses many challenges, particularly in quality requirements and new equipment investment. If a manufacturer has any hope to succeed, emphasis in these areas is necessary. Companies like

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Vancouver Gear Works Ltd., Iwasa Tech (Japan) and ATA Gears (Finland) are committed to this market segment and are all preparing for increasing demand in spiral bevel applications.

***VanGear Collaborates with Iwasa Tech***. Vancouver Gear is a provider of specialty gear manufacturing services in Western Canada. Originally founded to provide aftermarket replacement parts for the flourishing coastal marine industry, the company has since branched out to other industries (oil and gas, forestry and mining) and has continued to develop into a specialty jobbing facility. Iwasa Tech began sending large bevel gear sets milled by CNC machining centers in 2009. In November 2010, the company opened Iwasa Tech USA Inc. in Chicago and started its worldwide sales and service by spring of 2011 as an associate member of AGMA.

**Jim Mantei, vice president of business development at Vancouver Gear.**

For both companies, the biggest challenge in 2011 will be to expand the market share for large spiral bevel gears above 1,200 mm PCD in the worldwide market, according to Yoshikazu Abe, president at Iwasa Tech and chairman of the Japan Gear Manufacturers Association (JGMA).

"We are in a position to supply five-axis CNC hard finished milled tooth profiles to very high quality levels, and we're strategically aligning ourselves with VanGear to penetrate this market segment. In the meantime, our sales office in Chicago is expected to develop overseas sales of a variety of gears in the worldwide market," Abe says.

Both Iwasa Tech and Vancouver Gear have invested heavily in ISO-certified quality management systems since spiral bevel gears are used in applications with these stringent high-quality requirements (Iwasa Tech currently can manufacture to a DIN 2–3 class or AGMA Q 14–15).

**Yoshikazu Abe, president at Iwasa Tech.**

Another

area of focus is to minimize distortion during the carburizing heat treating process to provide consistent and proper effective case depths. The tooth finishing is done by five-axis CNC milling, and extensive research utilizing the most suitable tooling and optimized cutting gives the ability to hard finish to a very high quality and surface finish level.

Iwasa Tech has been manufacturing spiral bevel gears the traditional way on a Klingelnberg spiral bevel gear generator for many years. More recently, the company invested heavily in five-axis CNC machining technology for both spiral pinion shafts and gears.

"Both Vancouver Gear and Iwasa Tech are committed to continued investment in new equipment to enhance our capabilities to provide great customer service by reducing lead times and providing customers with viable options to the traditional method of manufacturing spiral bevel gears. We've had good success in Asia and now want to offer this technology to North America," Abe says.

Pulverizers and cement crushers for the power generation industry and thrusters for the marine industry have contributed to an increase in Iwasa's spiral bevel gear business in the past few years, but the forecast for the marine industry is a bit of a downward trend, as demand for new marine vessels is slowing at the moment but expected to rebound sharply next year. In general, business is good. "We've been growing at a rate of about five percent per year over the past five years and we expect this to continue for the next few years," Abe says.

Iwasa Tech and VanGear will be exhibiting at Gear Expo 2011 with an emphasis on its spiral bevel product line.

***ATA Gears Preps for Spiral Bevel Growth***. ATA specializes in the design, production and sale of customized spiral bevel gears for the vehicle, heavy engineering and marine industries. The company's main emphasis is the continuous training of ATA employees to meet the ever increasing quality requirements found in the spiral bevel market. Currently, ATA offers high-quality ground or skived spiral bevel gears in the range of 2–120 inches.

"We work closely with leading universities and research institutes so that we always have the latest knowledge and know-how in the spiral bevel field," says Heikki Stranius, sales director at ATA Gears. "Manufacturing methods in gear cutting have developed dramati-

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cally. The new five-axis machines offer interesting possibilities to bevel gear manufacturers."

ATA Gears has always been in the high end of spiral bevel gear business where requirements and tolerances are traditionally very tight, according to Stranius. "Today, we pay a lot of attention to the topography and heat treatment of large size spiral bevel gears. We invest an average of 10–15 percent of our turnover every year in new machinery."

ATA Gears opened a brand new factory location in 2009, offering additional space of 50,000 square feet with an investment plan to purchase $15 million in new equipment to increase capacity (equipment includes gear generators, CNC machining centers, CMM checkers, etc.).

The company quickly recovered from the recent economic slowdown and is currently seeing improvements in all business sectors. "We see increasing demand in the market for high quality spiral bevel gears. With the help of our latest and future investments, ATA is prepared for even more growth in the next two to three years," Stranius adds. "Price competition is one of the big challenges in the global market. ATA Gears is striving hard to meet price competition. We also see that delivery performance must improve in the future. We see growth in all segments such as marine applications and other heavy-duty gear applications."

Though the company will attend two to three trade shows in Europe and Asia this year, they have not decided yet if they will be attending AGMA's Gear Expo.

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# Gleason

## INVESTS IN COARSE-PITCH HOB PRODUCTION CELL

In response to unprecedented global demand for large cylindrical gears, Gleason Cutting Tools Corporation has invested in an advanced coarse-pitch hob production cell to reduce delivery time to as little as six weeks on a full range of large roughing and finishing hobs. The new hob cell, in combination with lean manufacturing methods, speeds production of coarse-pitch hobs complete from barstock including on-site final inspection of all critical hob features. The hob cell has also enabled Gleason to expand its product range to include hobs as large as 450 mm in diameter, 530 mm in length, and up to 40 module. This product offering includes Gleason's

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popular E-Z Cut hob, which features a unique flute design that adds extra cutting edges and delivers rough cutting feed rates up to 70 percent faster than conventional hobs. In addition, the hob cell gives Gleason the ability to produce the finishing hobs, ground to AGMA Class AA classification and with any desired profile or special involute modification.

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# Romer

## LAUNCHES NON-CONTACT LASER SCANNER

Romer Inc., a brand of Hexagon Metrology Inc, has announced the launch of the CMS108, a high-precision, non-contact laser scanner available for their portable coordinate measuring machines. The newest option in Romer's laser scanning portfolio, the CMS108, is the most adaptable and adept at scanning a wide range of materials with enhanced sensitivity to color and surface finishes. Its improved accuracy makes it attractive for inspection and reverse engineering applications where laser scanners have been unable to meet tight tolerances. The CMS108 mounts with a kinematic joint to the seven-axis Romer portable CMMs, which include the Absolute Arm SE and the Infinite

2.0 SC Arm. The CMS108 is the most precise laser scanner offered by Romer, with an accuracy of 20 microns—that is a 16 percent gain in accuracy over previous scanning solutions. In addition, the device was engineered for applications with a wide variety of color and surface finishes. Flying dot technology allows the laser scanner to rapidly detect changes in color and surfaces via their reflectivity. An operator can scan traditionally difficult finishes, including shiny and mirrored surfaces, without making manual exposure adjustments. The laser scanner can transition from matte to shiny features without additional calibration. With three different line widths and differing point densities, the CMS108 is able to perform inspection routines on small intricate parts and large surfaces.

"The CMS108 is the perfect addition to our portable scanning portfolio," states Eric Hollenbeck, Hexagon Metrology's product manager for portable products. "With versatility and an exceptional data collection rate, we now offer an incredibly accurate scanner capable of inspecting different consecutive surfaces on the fly with no adjustments. The CMS108 system integrates our industry-leading Scanning System Specification which specifies and calibrates the arm and scanner as a single unit. Although any organization with portable metrology requirements could potentially benefit from this technology, typical users include those in the automotive, aerospace, medical, rail and energy production industries. The addition of the CMS108 to our lineup demonstrates Hexagon Metrology's commitment to offering the customer unrivaled choice in portable metrology."

The CMS108 is currently available for the seven-axis Absolute Arm SE with measuring ranges of 2, 2.5, 3, 3.5, 4 and 4.5 meters. The sensor can also be added as an upgrade to the seven-axis Infinite 2.0 SC Arm.

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Both products are produced in the new, state-of-the-art facility in Oceanside, California.

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# C & B Machinery System

## DOES THE WORK OF THREE MACHINES

C & B Machinery of Livonia, Michigan has improved productivity and flexibility of their double-disc non-coplanar connecting rod grinding system, first introduced in 2009 for the Chevrolet Volt 1.4 L auxiliary engine. The first grinding system produced a stepped connecting rod from a parallel (or coplanar) rod. The 1.4 L Chevy Volt connecting rod has a 1.2 mm symmetrically smaller crankshaft end width, and both the pin and crank ends of the rod are ground in one sequence. At the time, the system was considered the most advanced double-disc grinder ever produced by C & B.

This latest system, recently shipped to Eston Manufacturing Division of Linamar Corporation, is grinding a 1.8 L connecting rod with a symmetrical reduction of the pin end of 3.8 mm. As before, the challenge was to produce this part from a coplanar connecting rod in one operation. Stock removal from the pin end of the connecting rod is 5 mm and stock removal from the crank end is 1 mm. Previously, this connecting rod required three grinding operations to complete and the crank and pin end were ground on two separate machines.

C & B's application engineers took the challenge to develop a special tooling package and unique two-stage grinding cycle, which first rough grinds the pin end to a stock condition equal to the crank end. It

then finish grinds the crank and pin ends of the connecting rod simultaneously. Grinding the crank and pin ends at the same time produces much better symmetry between the two. Additionally, the grinder easily exceeds Eston's 1.67 Ppk requirements for size, parallelism and flatness. The grinding system also includes a post process gaging system with automatic feedback to the grinding wheel infeed servos, providing automatic compensation for wheel wear. The gage also inspects step relationship between the crank and pin end faces.

The C & B model DG-2H-30/SA Connecting Rod grinding system has the ability to grind parallel parts, non-coplanar parts, pin end only or crank end only configurations with very simple changeover. This bodes well for meeting today's manufacturing requirements—lower production rates, better flexibility and a never-ending demand for lower machining costs per piece. With models utilizing up to 42" diameter grinding wheels, large diesel connecting rods can also be produced in this manner.

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# Mahr Federal's MarForm Series

## GETS UPGRADES


Mahr Federal will be featuring the new version of their successful MMQ 400 series, the MarForm MMQ 400-2, at Quality Expo 2011, September 20–22, 2011, at McCormick Place North, Chicago, Illinois. Mahr Federal will occupy booth # 600. The MarForm MMQ 400-2 integrates a new controller which allows the measurement of surface finish parameters according to ISO, ASME and JIS standards. With dramatically increased speed and resolution, the MMQ400-2 samples data with spacing as tight as 0.005 microns. Benefits include reduced set-up and cycle times, and cost savings from using a single system for both form and surface measurements.

The MarForm MMQ 400-2 Formtester was a ground up redesign which delivers a machine that is more robust, less sensitive to environmental influences, faster, more flexible and more accurate than comparable systems. The MMQ 400-2 offers an impressive array of features, including extremely solid construction with a generously dimensioned, reinforced steel base. High-precision mechanical bearings for the rotary table eliminate the need for an air supply, and all motors and electronic components have been thermally isolated to enhance stability. Wherever possible, homogeneous materials have been used in construction to minimize the

effects of thermal expansion.

The skidded probe roughness package for the MMQ 400-2 utilizes the same diamond- tipped PHT stylus, as is used on Mahr Federal's popular PS1 and M300 surface finish machines, and the same *MarWin*-based surface finish software as the MarSurf XR 20. The stylus is mounted opposite the ruby-tipped form probe on the MMQ 400-2's motorized T7W probe head. The MMQ 400-2 automatically swivels the probe to apply the diamond stylus, and changes from horizontal to vertical measurement as needed, utilizing standard surface finish parameter cut-off lengths. A skidless probe measuring option is also available utilizing diamond-tipped styli that are directly mounted to the T7W probe head.

Several versions of the MMQ 400-2 Formtester are available. Options include: manual or motorized center and tilt tables; vertical Z-axis length of 350 mm, 500 mm or 900 mm for long shafts; and horizontal X-axis of 180 mm or 280 mm. All measuring axes are fully motorized. A selection of available probes—including the T7W 360 degrees motorized bi-directional probe and the manual T20W probe—further enhances measuring flexibility.

Also on display at Mahr Federal's Quality Expo booth # 600 will be the new MarCheck measuring and evaluation unit for Mahr's high-precision Linear 100 universal length measuring instrument, the new generation of MarCal digital calipers and the new Digimar 816 CL Height Gage, along with a full range of other Mahr Federal handheld gages and other dimensional metrology products.

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# Seco Tools Inserts

## DEBUT AT CANADIAN MANUFACTURING SHOW

Seco Tools will introduce new turning insert grades and chipbreaker inserts within its exclusive Duratomic coating product line at the 2011 Canadian Manufacturing Technology Show. The company will occupy booth # 2726 at the event, which takes place October 17–20 at the Direct Energy Centre in Toronto.

Two new insert grades appearing at the show are TK1001 and TK2001. These are the latest additions to Seco's Duratomic family of turning and milling insert grades. Additionally, there will be a large offering of geometries and chipbreakers designed for the ISO K10-K20 range of cast materials, such as grey and ductile irons.

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