

# An Emphasis on Accuracy

## MEETING THE MANY CHALLENGES OF LARGE GEAR INSPECTION

Matthew Jaster, Associate Editor

The large contracts in gear manufacturing are vital to a company's bottom line. Ask any gear manufacturer involved in the mining, tunnel boring, wind or heavy equipment industries



Options such as roughness measurement and overheating detection during the grinding process offer additional practical test procedures on Klingelnberg inspection machines (courtesy of Klingelnberg).

and they'll agree. In order to promote longevity in this market segment, these large gears cannot fail. While big gear manufacturing hints at larger financial opportunities, it also means that the quality/inspection has to be unsurpassed. Companies like Wenzel, Gleason, Klingelberg and Hexagon Metrology are consistently improving their quality/inspection capabilities with this in mind.

### **Inspection Machines to Fit Your Needs**

Is the equipment reliable? How does the service and support measure up? What new features have been implemented that will interest potential customers? These are all valid questions in regards to inspection equipment. Reliability, productivity and precision are all critical components to Wenzel's product offerings. "In an industry such as gear metrology there is no room in the market for a product whose aim isn't to be the most accurate system," says Elliott Mills, gear product manager at Wenzel America. "A Wenzel machine is a robust and reliable system due to its granite construction and air bearing design; this is a wear-free system. Our large capacity hydrostatic rotary tables are also wear-free. We eliminate the fail modes as opposed to managing them."

Cycle times for Wenzel machines are not an issue, according to Mills, as the company strives to achieve its productivity outside of the inspection cycle. "We look to eliminate change-over time between cycles using innovative part fixturing systems and offline programming. A machine should not sit idle while there are parts awaiting inspection."

This year, the company has a new machine being delivered to a customer. The WGT-4000 machine is capable of measuring four-meter gears with two meters between centers and a two-meter measureable face width. "We will be delivering a WGT-4000 to a very well-known German manufacturer of grinding equipment," Mills says, "Additionally, we have some exciting software developments that will be on display at the EMO and AGMA shows later this year."

Before releasing inspection equipment, all Klingelberg gear testing machines undergo extensive internal

acceptance testing. "This ensures a high degree of uniformity among measurement results across all machine models," says Gunther Mikoleizig, head of product management gear inspection machinery at Klingelberg. "This is all the more important for companies that intend to use a combination of gears produced internationally. Highly durable machine components and state-of-the-art drive and measurement systems in all modules provide the basis for such results."

While the capability of testing toothed gear flanks has been available for some time, the option for checking overheating during grinding is now available on Klingelberg machines. "For large gears, this obviates the need for additional time-consuming test operations on other devices," Mikoleizig says. "Another improvement is the new probe calibration program Stylus Manager that allows probe elements to be selected individually and calibration procedures to be performed with the workpiece mounted."

Gleason Metrology Systems (GMS) machines start off with the traditional foundation for the majority of inspection machines, a granite base. "But not just any granite base," says Dennis Traynor, sales manager at GMS. "The material supplied by GMS has a very small, very dense, crystalline structure to avoid humidity absorption. To this base we add a large-diameter, high-workpiece-weight-capacity direct drive rotary table. Finally, we add our X-Y-Z compound axes constructed of Meehanite cast iron, all driven by linear motors for smooth, reliable, trouble free operation. All these mechanical subsystems are then controlled by *GAMA (Gleason Automated Measurement and Analysis)*, an object-oriented (native Windows-based) suite of gear and gear tools applications software.

GMS is continually improving its product offering, and this year marks the introduction of the new GMS series five-axis machines that will debut at EMO in Hanover, Germany this September. "GMS' five-axis machines traditionally support the large gear sector, in particular wind energy applications. We will have on display a

2000GMS model which will display all the features we have previously mentioned as well as some unique workholding strategies," Traynor adds.

### **Updating Inspection Capabilities**

Klingelberg began offering testing machines for large gearing back in the 1980s. Since then, the company has continued to update its inspection capabilities based on market demands. Software is one area that has seen continuous improvements. "The current software modules are designed to Microsoft Windows standards offering a familiar interface, and the use of graphical symbols makes the interface essentially self-explanatory and shortens the learning curve for new staff," Mikoleizig says. "By making simple, specific changes to an existing measuring procedure, new procedures can be created quickly and easily. The user interface can easily be switched to another language setting and even another character set—such as Chinese."

Klingelberg's software department provides comprehensive, continuous service to its customers. "Alongside their theoretical gearing knowledge and participation in working groups for the development of new standards, our experts also update the software to keep pace with continuous advances in hardware, including the latest operating systems," Mikoleizig says.

Being a modular program, Gleason's *GAMA* software utilizes preconfigured tolerance tables for industry's most popular industrial standards. *GAMA* also supports most of the world's leading gear OEMs with custom analysis modules particular to their proprietary gear analysis standards. "We have incorporated many modern-day features like digital images embedded in the software to confirm proper part and orientation, voice mail messages embedded in the program for operator-to-operator or manager-to-operator communications to convey the latest updates in part geometry or fixture changes, etc. Finally we have incorporated a webcam into the remote operator pendant to allow for still image capture, or live video streaming of the inspection process, convenient for communicating issues to engineer-

**continued**

ing, customers, or other quality staff,” Traynor says.

In addition, *GAMA* utilizes a very intuitive operator interface which contains both text and graphical information about the part and its setup, and

has a logically menu driven structure to support a feature-rich part programming routine. “We also offer features like “Center Part” that allow the machine to probe the workpiece radially and axially at its journals, calculate

the eccentricity of the rotary axis, and then allow the software to guide the operator to easily true the part. Part data can be recalled at any time and is organized in a variety of ways: by part number, by part type, by customer, etc. *GAMA* also stores part inspection output data in either pdf file formats or SVG (Scalable Vector Graphics), an HTML style output, small in file size and easily emailed and viewed with no special software,” Traynor says.

“Any internet browser will open the file and display the measured results. Additionally, actual raw data can be recalled and re-analyzed under different standards or parameters without having to re-inspect the gear physically. *GAMA* also supports the world’s languages. Either the interface or just the output charting can be easily converted to over 25 different languages used worldwide, supporting today’s global sourcing strategies.”

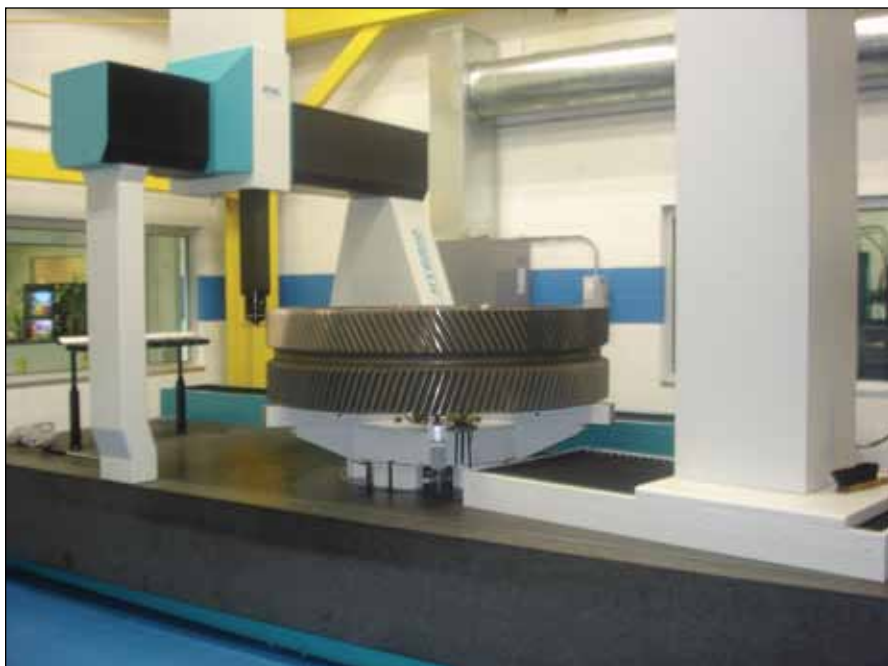
#### **Large Gear Inspection: A Cheat Sheet**

While many companies struggled during the recent economic crisis, Wenzel America’s staff actually grew. “We added additional applications and service support through both strategic hiring and cross training many of our service and applications engineers to best match our capacity to our demand. We have numerous customers who have different Wenzel products and it allows us to be flexible with staffing and to better cover a large geographic area,” Mills says.

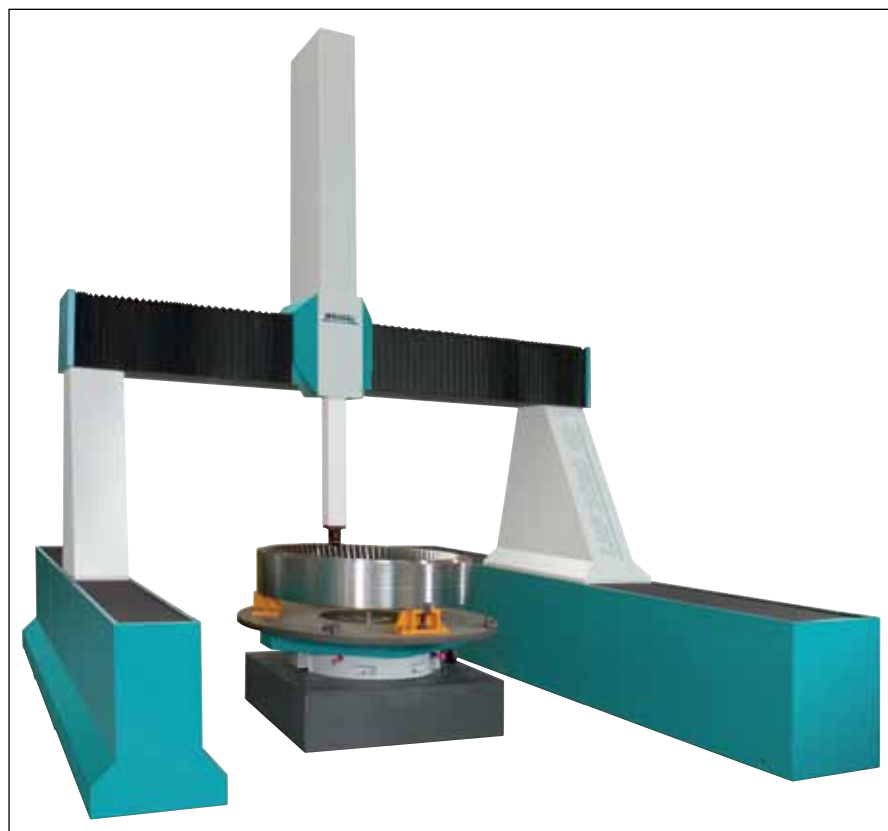
Wenzel can handle measurements up to five meters in diameter with what are standard products, not tech specifications or a design concept.

In the large gear market, Klingelnberg offers gear testing machines for large workpieces in the range of 1,800 mm, 2,800 mm, and 3,800 mm in diameter, with machines for 4,000 mm and 6,000 mm coming soon. The permissible workpiece weights are in the range of 8,000 kg, 15,000 kg, 20,000 kg and 40,000 kg. Workpieces can be up to 3,000 mm long with a measuring range of up to 2,000 mm in one fixture.

GMS offers four different machines that fall into the large gear sector. They are 1,000 mm, 1,500 mm, 2,000 mm and 3,000 mm capacity systems, with



**Reliability, productivity and precision are all critical components to Wenzel’s product offerings (courtesy of Wenzel).**



**Wenzel has two distant product lines for large gear inspection, traditional gear inspection machines and CMM gear inspection machines (courtesy of Wenzel).**

the latter three being five-axis systems. The model numbers (1000GMS, 1500GMS, 2000GMS and 3000GMS) denote the maximum diameter work piece. "All systems are available with extended Z axis or tail stock travels to accommodate taller workpiece or tooling build up geometries. Machines of this size have a myriad of fixturing and tooling options, which are typically identified during our presales interview process. All of our machines also have the capability of prismatic geometry inspection which is very typical with today's wind energy components," Traynor says.

The PMM-G, a custom configured product built by Hexagon Metrology GmbH, is suitable for the extremely large gears used in the windpower industry, for power generation, and power transfer products. The system is not a single-purpose inspection station just for gears, but a fully capable coordinate measuring machine that can be used to inspect many other kinds of large machined assemblies, such as gearboxes and engine blocks.

"The PMM-G represents the ultimate in Leitz large-scale gear inspection," said Pete Edge, product manager, Leitz products. "Unlike other gear inspection products, it does not require a rotary table, which makes part loading and unloading much easier. It also allows a maximum part weight of 15 metric tons."

The PMM-G is available in 55 standard measuring sizes ranging from 3,000 mm x 2,000 mm x 1,200 mm to 7,000 mm x 4,000 mm x 3,000 mm. The maximum part load is 15 metric tons. Gear types inspected include cylindrical gears (spur, helical, double helical, internal and external spline, internal and external clutch, gear segments and gear racks) plus straight, spiral and hypoid bevel and crown gears. Gears can be evaluated to all major standards including DIN, ISO, AGMA, ANSI, JIS, CNOMO and CAT.

#### Additional Measuring Tasks

For a number of years, Klingelberg machines have also been qualified for additional measuring tasks beyond gear

measurement. "The ability to carry out dimension, form and position measurements on drive components provides the conditions for nearly complete measurement," Mikoleizig says. "Options such as roughness measurement and overheating detection during the grinding process offer additional practical test procedures. The expansion of the model series for workpieces up to 6,000 mm in diameter and weights of up to 40,000 kg will enable a qualitative assessment of additional drive components in the future."

Milwaukee Machine Works recently purchased a Leitz PMM-G ultra-accurate CMM from Hexagon Metrology that is tailor made for large-scale machined components. "The primary capability for our application was size in conjunction with accuracy," says Mike Manna, general manager at Milwaukee Machine Works. While the company is machining most of the exterior parts for the larger geared products, it does not inspect gears at this time. "We expect to define

**continued**

## All The Gear Cutting Tools You Will Ever Need Are Right Here DTR is one of the world's largest producers.

### DTR. Your best choice for high quality gear cutting tools.

DTR is a world class supplier of the finest high performance long-life gear manufacturing tools, for small and large gear cutting applications. Established in 1976, we are one of the world's largest producers of cutting tools, shipping to over 20 countries.

DTR offers a full line of gear cutting tools including:

- Hobs
- Carbide Hobs
- Shaper Cutters
- Milling Cutters
- Chamfering and Deburring Tools
- Broaches
- Master Gears

We can produce virtually any tool you need for auto, aerospace, wind, mining, construction and other industrial gears.

Every tool is precision-made utilizing high speed steel, premium powder metal or carbide and the latest in coatings, to achieve superior cutting and long life. DTR uses top of the line equipment including Reischauer CNC grinders and Klingelberg CNC sharpeners and inspection equipment.

Learn more about our outstanding quality tools at [www.dragon.co.kr](http://www.dragon.co.kr).

Call us at 847-375-8892 for your local sales representative or  
Email [alex@dragon.co.kr](mailto:alex@dragon.co.kr) for a quotation.



**DTR**

PERFECTION MOVES US

(formerly Dragon Precision Tools)

[WWW.DRAGON.CO.KR](http://WWW.DRAGON.CO.KR)

**DTR has sales territories available. Call for more information.**

U.S. Office Location (Chicago)

Email inquiries to: [alex@dragon.co.kr](mailto:alex@dragon.co.kr)

2400 E. Devon Ave., Suite 210, Des Plaines, IL 60018

PHONE: 847-375-8892 Fax: 847-699-1022

Headquarters

36B-11L, Namdong Industrial Complex, Namdong-Gu, Incheon, Korea

PHONE: +82.32.814.1540

FAX: +82.32.814.5381

whether there will be a market for gear inspection in this area,” Manna says. “This will drive the decision on purchasing the gear inspection software for the machine.”

The challenges with inspecting large gears include standard issues associated with handling any large parts made to precision tolerances. Manna adds, “This requires a

clear understanding of the equipment that will be used to move the parts and address these issues ahead of time. Once presented for inspection, the appropriate probes and appropriate temperature control are critical to assure correct measurement.”

As a rule Hexagon is a cooperative, professional supplier who understands the urgency of repairing a piece of manufacturing equipment that goes down. “They will do what it takes to support us. They also have a comprehensive training program and users group to further our knowledge and understanding of the inner workings of the equipment we use,” Manna says.

With the Leitz probe head and *QUINDOS* software, Leitz measuring machines from Hexagon Metrology are increasingly used to measure all kinds of complex toothed gears. Compared to conventional gear testers, these machines can inspect all kinds of toothed wheel work and cutting tools without the need for a rotary table. This translates into higher system accuracy, above all with heavy wheels, simple mounting without guides and centering devices and lower capital and maintenance costs.

Wenzel has two distant product lines for large gear inspection, traditional gear inspection machines and CMM gear inspection machines. “Of course, the two meet with our hybrid machine which is essentially a combination of both. Wenzel offers dedicated gear inspection machines up to five meters as a standard product. Our LHGear machines are traditional CMM frames coupled with a 4th rotary axis and are the perfect solution for customers who have prismatic inspection needs in addition to large gears.”

Mills notes that the company boasts a design team that takes on special projects where customers have inspection challenges that are outside of the capability of standard products offered in the industry.

#### Inspection Wish List

So where do these inspection professionals see this market segment heading in the future? “We are constantly looking at many technologies to offer more beneficial features and options to our customers,” Traynor says. “We continuously look at new



Complete inspection of gears as large as one meter in diameter now can be performed up to 25 percent faster with the Gleason 1000GMS Analytical Gear Inspection System (courtesy of Gleason).



Extensive internal acceptance testing is performed before machines hit the market (courtesy of Klingelnberg).

and innovative ways to inspect the finite geometry of gears. We also evaluate sensor technologies, controls technologies and mechanical subsystems to improve accuracy and uptime requirements.

“Given Gleason’s strong after sales strategies and the robust features of *GAMA*, we are capable of supporting our systems virtually anywhere in the world. We have several systems installed in the far reaches of the gear manufacturing community and these machines are fully operational and fully functioning each and every day. In addition to our online strategy, Gleason has local field service engineers located in virtually all of the world’s established markets and many of the emerging markets.”

Mikoleizig adds, “Modern gear testing machines are equipped with temperature-neutral measurement systems and use appropriate sensors to monitor the temperature of individual modules. All guides and measurement systems are equipped with covers. The materials used in the measuring machines are suitable for use in a production setting. The use of measurement technology on the production floor is aided by the overall improvement of conditions in modern production facilities.”

“I think we will continue to see traditional gear inspection machines in labs and on floors in the future,” Mills says. “Demands for longer life of gears with continue to tighten tolerances and requirements for elemental gear inspection will continue to grow, parts that weren’t required to be inspected five years ago are today. Parts that were not feasible to inspect in the past can be inspected with innovative thinking, these barriers will continue to be eroded.”

**For more information:**

Gleason Corporation  
1000 University Avenue  
Rochester, NY 14692  
Phone: (585) 473-1000  
[www.gleason.com](http://www.gleason.com)

Hexagon Metrology Inc.  
250 Circuit Drive  
North Kingstown, RI 02852  
Phone: (401) 886-2000  
[www.hexagonmetrology.us](http://www.hexagonmetrology.us)

Klingelberg  
1465 Woodland Drive  
Saline, MI 48176  
Phone: (734) 429-7225  
[www.klingelberg.com](http://www.klingelberg.com)

Milwaukee Machine Works  
404 South 116th Street  
Milwaukee, WI 53214  
Phone: (414) 476-3285  
[www.milwaukeeemachineworks.com](http://www.milwaukeeemachineworks.com)

Wenzel America  
46962 Liberty Drive  
Wixom, MI 48393  
Phone: (248) 295-4300  
[www.wenzelamerica.co](http://www.wenzelamerica.co)



With the Leitz probe head and **QUINDOS** software, Hexagon Metrology can offer gear measuring capabilities (courtesy of Hexagon Metrology).

**A Better Way**  
The “NDG” Method  
(patented)

**New Power for your Gear Measuring & Inspection Systems**



- Fast & Accurate gear measurement from a small gear up to a super large gear
- User Friendly



**USA Office**  
Tokyo Technical Instruments USA Inc.  
297 Kinderkamack Rd., #133  
Oradell, NJ 07649  
Ph: 201-634-1700  
Fax: 201-262-2187

**Japan Headquarters**  
Tokyo Technical Instruments Inc.  
Main Office Ph: +81-3-3726-4188  
Factory Ph: +81-284-73-1733

See Details  
[www.tti-geartec.jp](http://www.tti-geartec.jp)