

2019/2020

# solutions

gear manufacturing technology magazine

## Combi Honing eDrive Gears

## EV Transmission Design

Charging Ahead with KISSsoft and GEMS

## Keeping It Quiet

Gear Noise Analysis with the GMS Series

## Technology in Action

Mercury Marine Goes Boldly

Warn Auto Picks Up Speed

Great Wall Powers Up

Total Gear Solutions

**Gleason**

# Welcome to Gleason



John J. Perrotti

President and  
Chief Executive Officer

Dear Valued Customers:

The bar for gear performance has never been higher in terms of efficiency, duty-cycle and noise emissions. With the growth of Electrical Vehicles, quality requirements are increasing. Meeting these challenges requires an intelligent systems approach that connects design, manufacturing and inspection.

At Gleason, we view design, machines, tooling, and inspection not separately, but as highly integrated solutions that can share data to continuously optimize your results. Taking this approach, however, isn't possible without 'smart' new technologies that easily work together:

The new interface between our KISSsoft® and GEMS® software has put manufacturing intelligence into gearbox and drivetrain design software so you not only have a better theoretical solution – but also one with defined production processes and cost and quality data. The power of this system is evident in our development of a better EV transmission, described in this issue.

In the case of eDrive transmission gears, Gleason can apply manufacturing technologies particularly well suited to meet these challenges. Our new Chamfer Hobbing process, for example, can produce any chamfer form desired, with no loss of productivity to prepare the tooth flank in advance of a hard finishing operation such as honing. With the addition of the Faessler gear honing business to our hard finishing portfolio, the Combi Honing™ process performs the hard finishing of gears to the highest quality standards for these applications.

Among the most important performance criteria for the finished eDrive gear is noise. With the GMS® series of inspection systems, Gleason offers several exciting new noise analysis solutions to help in the drive for quiet.

Most importantly, Gleason technologies are working together in a Closed Loop system so that gear development and optimization is always on-going. Inspection data becomes corrective settings sent back to the production machines or to a Cloud-based environment for future analysis. A good example is the GRSL laser-based in-process inspection system, which measures critical gear features in seconds so closed loop corrections are made in real-time by the production machines.

And there's much more. We look forward to telling you more about how we can help meet your objectives, no matter how high the performance bar is set.

A handwritten signature in black ink, appearing to read 'J. Perrotti', written in a cursive style.

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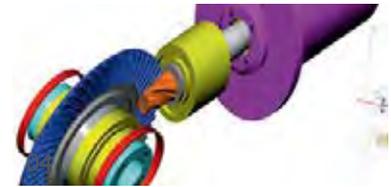
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# New EV Transmission Charges Ahead

Gleason KISSsoft and GEMS software prove their power, working together to develop a highly efficient EV transmission with hypoid gearset.

Inspired by a request from an Electric Vehicle manufacturer to find more cost effective solutions for EV transmissions, Gleason took up the challenge. Today, just a few short months later, Gleason has developed the design (patent pending) for a one stage super reduction hypoid (SRH) drive unit that offers EV manufacturers significant benefits over conventional EV transmissions. This drive unit includes the electric motor, which has a longitudinal orientation in a compact EV. Only one stage of reduction was required in order to realize a 1:10 speed reduction as shown in Figure 1. Most importantly, the project demonstrates the power of Gleason KISSsoft and GEMS design software working seamlessly together in a closed loop to empower engineers and help optimize gearbox and bevel and hypoid gear design.

## A Better Mousetrap

The project started with a thorough analysis of the most common EV-transmission concepts. Immediately obvious was the conflict EV transmission designers and

manufacturers face with the typical asymmetric designs. The major obstacles that exist with the “inline design” of the electric motor and a two stage cylindrical transmission include:

- Large width between the front wheels used for drive unit
- Asymmetric weight distribution
- Higher heat radiation to the wheel and tire on the side of the electric motor

The Gleason hypoid concept shown in Figure 1 addresses each of these liabilities. For example, it uses only a small space between the front wheels and allows for longer drive shafts. The weight distribution of the hypoid concept is perfectly symmetric. Additionally, the heat radiation to the front wheels is equal on both sides.

The use of short drive shafts, with each having to accommodate two CV-joints, results in a loss of efficiency, higher operating noise and high wear during steering actions and control arm swings. The asymmetric weight distribution has to be offset with other asymmetric vehicle components such

as the battery. However, there will still be an impact on the dynamic behavior of the vehicle. The permanent heat radiation of the electric motor, as shown in Figure 2, might increase the temperature of the adjacent tire by up to 20°C. Temperature insulation and an additional cooling fan can reduce the temperature of the tire adjacent to the e-motor but the consumption of electrical energy for the evacuation of motor heat is not something any EV manufacturer would like to see.

## Easier eDrives with KISSsoft and GEMS

It's obvious that the proposed hypoid concept eliminates many of the disadvantages of the “inline design” with a very cost effective one stage high reduction solution. Visitors who saw the concept demonstrated for the first time at the 2018 JIMTOF Machine Tool Show in Tokyo were very impressed. But perhaps what intrigued them most was the process: designing and optimizing an EV-drive unit using the KISSsoft system for the design of transmission, including electric motor shafts and bearings,

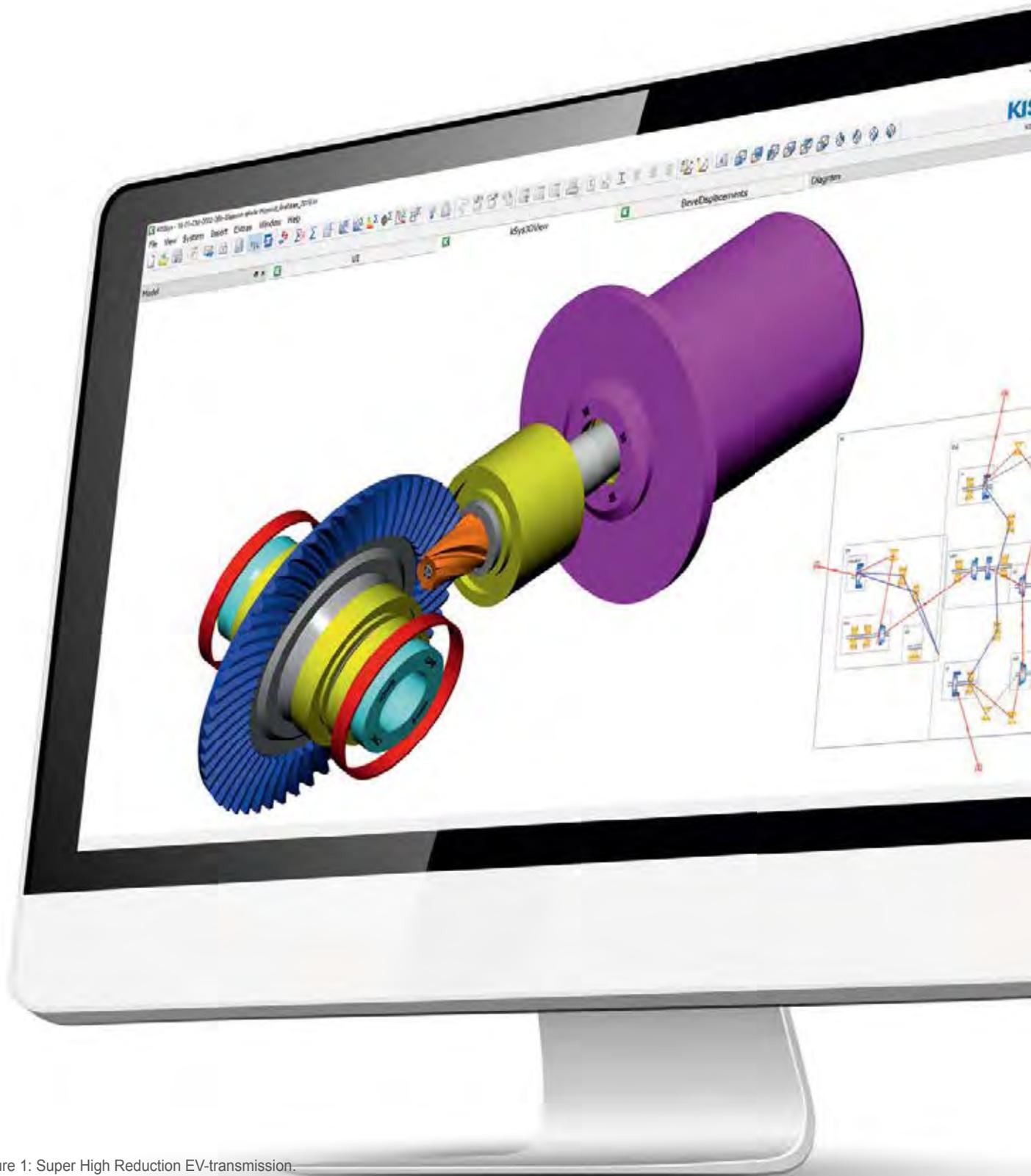


Figure 1: Super High Reduction EV-transmission.

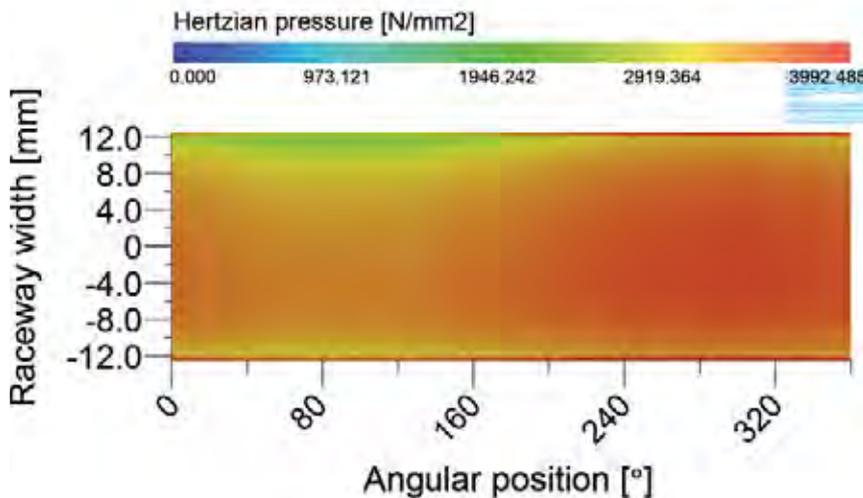


Figure 2: Bearing race surface stress calculation.

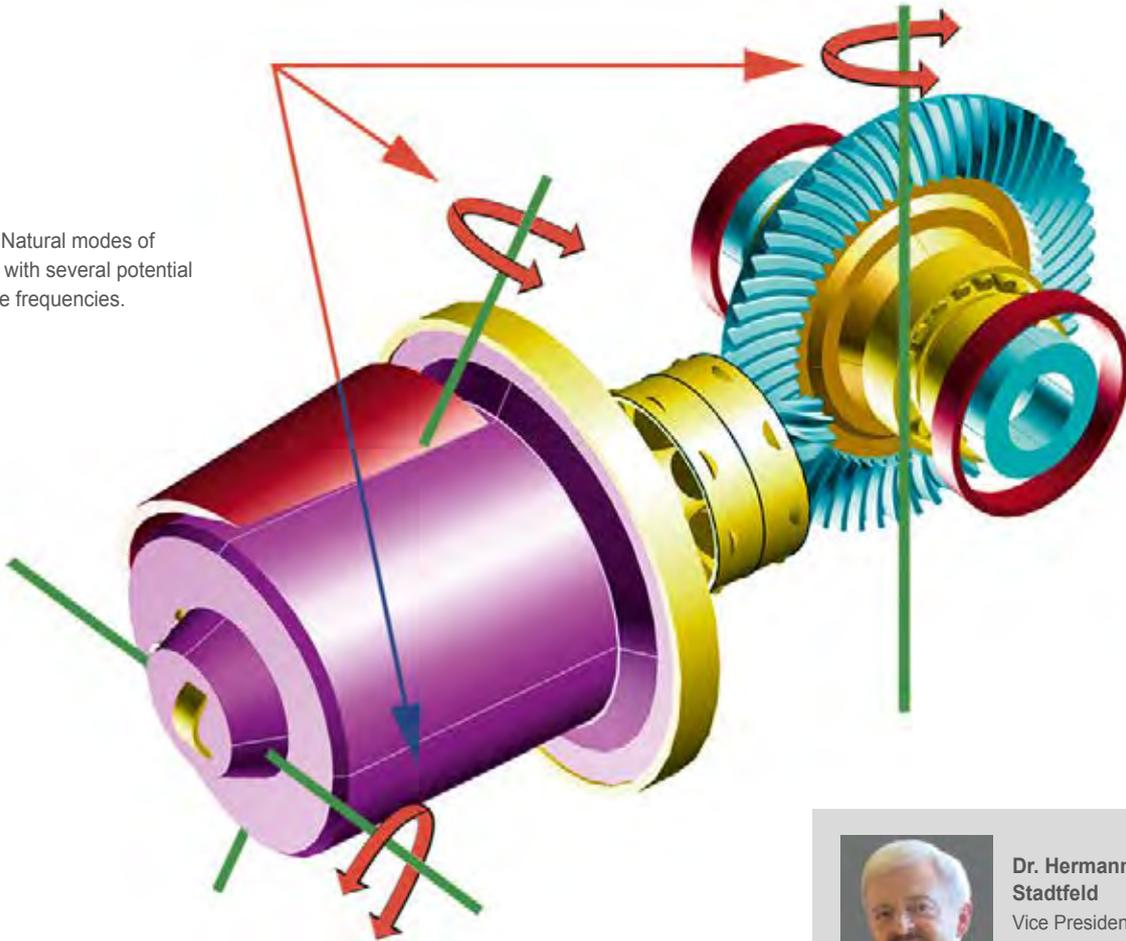
and using GEMS for the design and optimization of the hypoid gearset. It was apparent how seamless the KISSsoft-GEMS data interface works, providing a precise and fast interaction between the two Gleason software systems.

GEMS has the capability to design and optimize high reduction hypoids down to a single pinion tooth. In the case of the new eDrive transmission, between 4 and 5 pinion teeth deliver optimal ratios with the required back driving ability. GEMS offers an easy-to-use touch screen environment with apps for the different functions like “Base Design”, “Finite Element Analysis” and “Machine Summaries”. The new graphical analysis results make GEMS also easy to use for even inexperienced gear engineers and empowers them with the tools to develop bevel gearsets with extraordinary properties in the shortest possible time.

KISSsoft and GEMS complement each other for gearboxes with bevel and hypoid gear design. KISSsoft provides the system design and analysis, covering all elements in a gearbox. This includes the rating of gears, shafts and bearings regarding strength and lifetime. At the system level the calculation of efficiency, the thermal rating as well as housing deformations and resulting bearing displacements are performed. This also includes the misalignment calculation of the drivetrain shafts. As a standard function, KISSsoft can perform life cycle calculations for complex load and speed duty cycles in order to represent the operating condition of an eDrive optimally.

eDrives demand particular attention to bearings and shaft-hub connections. Compared to conventional drivetrains those components require in-depth analysis due to the high speed range of electric motors. The roller bearings, for instance, require the advanced calculation method based on ISO/TS 16281. This method analyzes the inner bearing geometry consisting of inner and outer race and the roller elements

Figure 3: Natural modes of drivetrain with several potential resonance frequencies.



with their individual loads. The surface stress distribution of an eDrive bearing as shown in Figure 2 is a key parameter for a precise life time prediction.

The higher speeds of the transmission components close to the electric motor can generate critical dynamic effects in the entire drivetrain. KISSsoft offers a modal analysis feature on system level which shows the natural modes of the drive train within the applicable speed range. The modal analysis as shown in Figure 3 indicate that the electric motor is subject of additional vibration which can be eliminated by optimizing the proportions of the housing and the dimensioning of the transmission components.

### In Summary

The fast, efficient and, ultimately, successful development of an eDrive transmission design is an excellent demonstration of the optimal combination of software tools that Gleason can apply. Ultimately, as the design moves from concept to reality, eDrive manufacturers will further benefit from the complete Gleason Closed Loop system that seamlessly connects design, manufacturing and inspection.



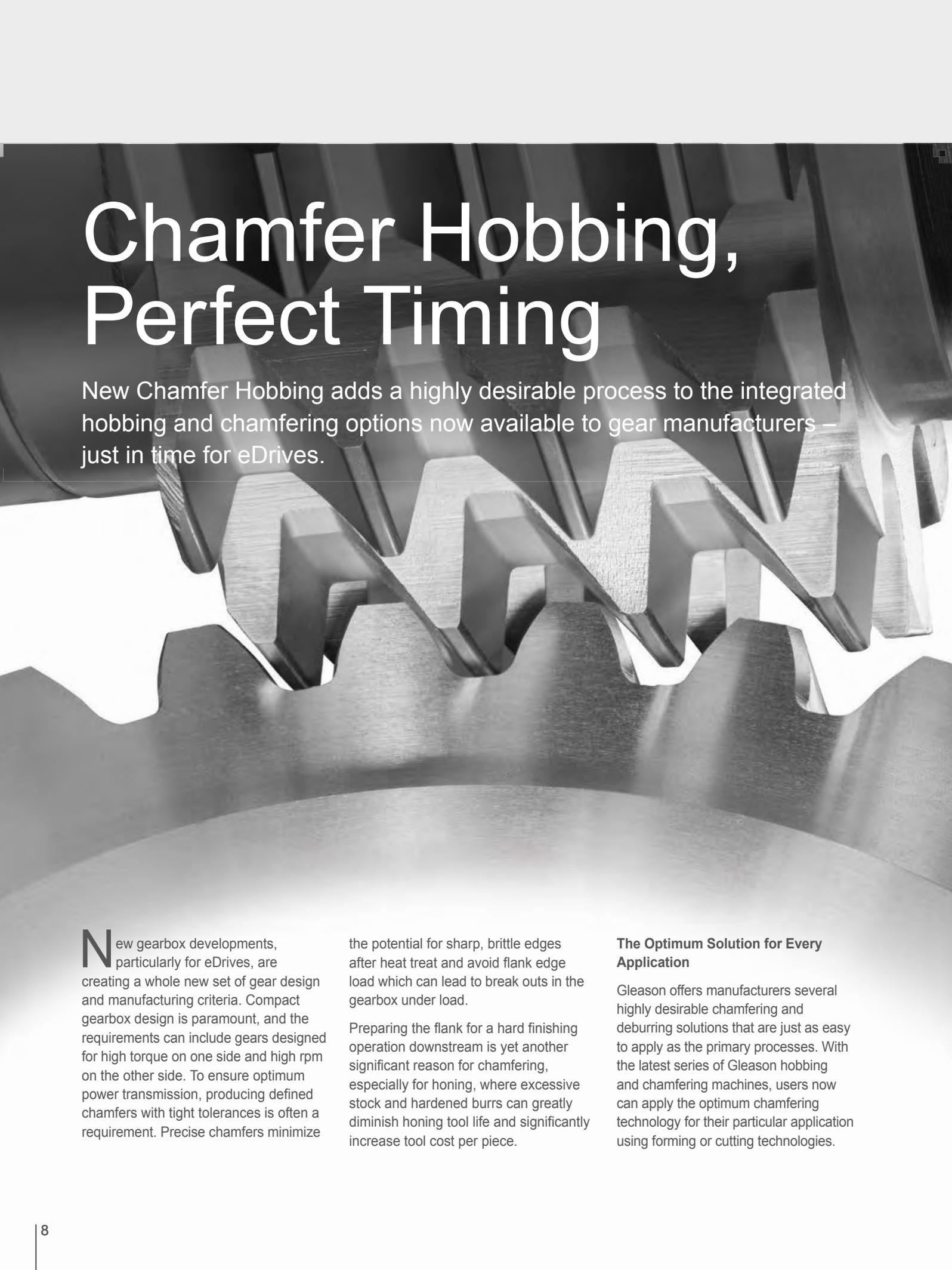
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# Chamfer Hobbing, Perfect Timing

New Chamfer Hobbing adds a highly desirable process to the integrated hobbing and chamfering options now available to gear manufacturers – just in time for eDrives.

New gearbox developments, particularly for eDrives, are creating a whole new set of gear design and manufacturing criteria. Compact gearbox design is paramount, and the requirements can include gears designed for high torque on one side and high rpm on the other side. To ensure optimum power transmission, producing defined chamfers with tight tolerances is often a requirement. Precise chamfers minimize

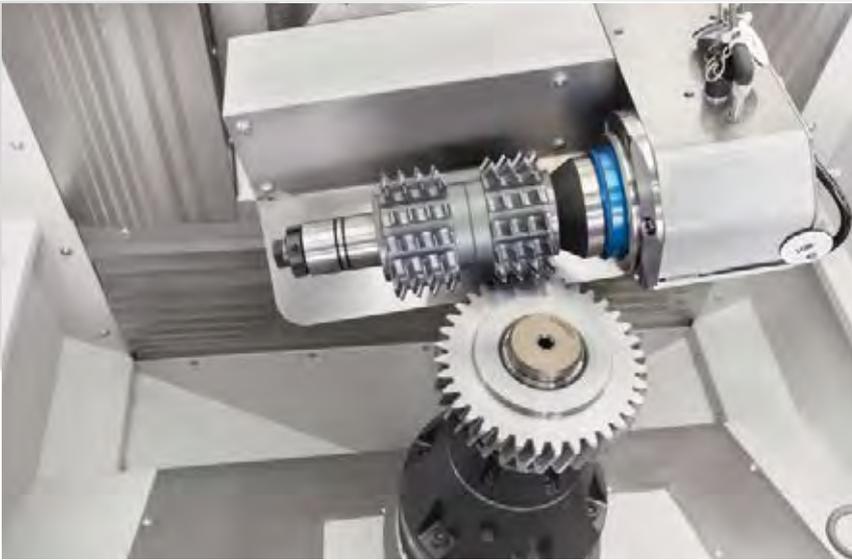
the potential for sharp, brittle edges after heat treat and avoid flank edge load which can lead to break outs in the gearbox under load.

Preparing the flank for a hard finishing operation downstream is yet another significant reason for chamfering, especially for honing, where excessive stock and hardened burrs can greatly diminish honing tool life and significantly increase tool cost per piece.

## **The Optimum Solution for Every Application**

Gleason offers manufacturers several highly desirable chamfering and deburring solutions that are just as easy to apply as the primary processes. With the latest series of Gleason hobbing and chamfering machines, users now can apply the optimum chamfering technology for their particular application using forming or cutting technologies.

# Chamfer Hobbing



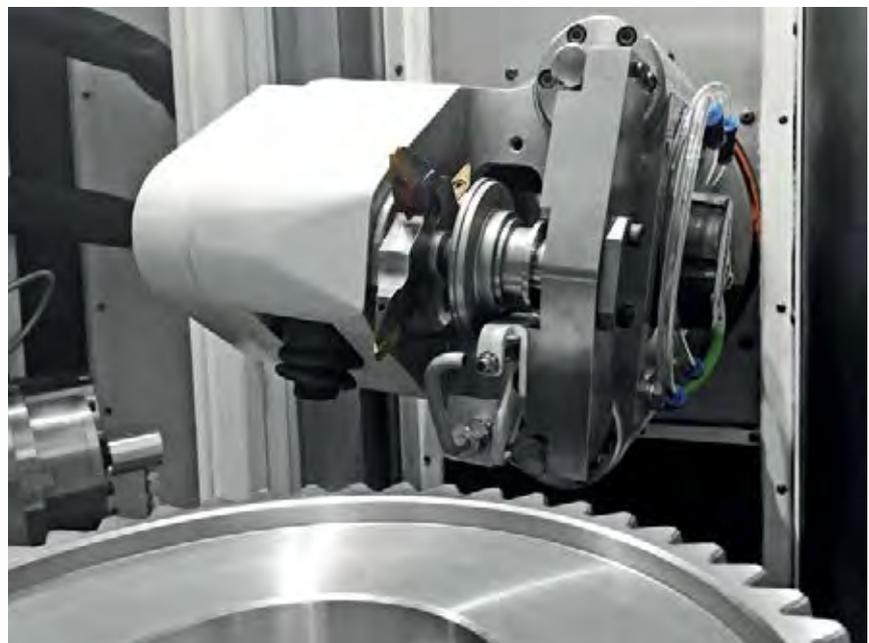
The new Chamfer Hobbing process offers an extremely efficient solution to create the desired chamfer without considerable secondary burrs.



Chamfer rolling process is done in parallel to gear hobbing on the Gleason P90CD horizontal hobbing machine.

These technologies include tried and true chamfer rolling, ideal for planetary pinions with cycle times of less than 10 sec. or for shafts with obstacle contours in high volume production; Chamfer Contour Milling, for highly flexible cutting chamfering with indexable carbide inserts for small and medium batch production of truck-sized gears; and now Chamfer Hobbing. Chamfer Hobbing is the process of choice for medium and high volume production and dry cutting for highest tool life with lowest tool cost per workpiece.

While chamfering with hobs has been known for decades, Chamfer Hobbing takes the process to a completely new level. Chamfering is performed using a Gleason Chamfer Hob. The new cutting tool has characteristics very similar to a gear hob. It's made with high-speed steel materials such as G30, and features AICroNite® Pro coating for exceptional tool life in dry cutting conditions. With Gleason Chamfer Hobbing, one Chamfer Hob is used for each tooth flank, with a tooth profile specifically designed for the



Contour Milling in parallel to gear hobbing on the Gleason 400HCD does not add cycle time and is ideal for truck-size gears.

particular chamfer form that's required. The Chamfer Hob looks similar to a standard gear hob but with asymmetric teeth. One flank is designed for cutting the chamfer, the other flank is designed to not touch the counter flank. Additionally, comma or parallel-

chamfer forms are possible as well as chamfers along the tooth edge only, or including the root area. Chamfer angles similar to those commonly produced in the chamfer rolling process are easily achievable (15-30 degree on obtuse edge, 25-45 degree on acute edge).

### Lowering the Cost Per Workpiece

In the Chamfer Hob design process, Gleason software is used to simulate the required chamfer and avoid all potential collisions of the tools with the counter flank and with interfering contours above and below the actual gearing. By cutting into the gap, burrs are avoided on the face side of the gears. With chamfer angles such as those produced by the chamfer rolling process, there are no measurable burrs on the flank that require removal downstream. Since Chamfer Hobs use materials and coatings similar to gear generating hobs, low tool cost per part is expected especially since tool shifting is possible. Ultimately, longer tool life leads to minimized changeover times and lower cost per piece.

While two Chamfer Hobs are sufficient for workpieces with parallel gear faces, up to four Chamfer Hobs on a single spindle could serve parts with asymmetric gear faces such as inclined gear faces, special gears or even two gears on a shaft – all of which could be chamfered in one set up.

### The Perfect Machine Platform

The new Genesis® 160HCD combines the proven Genesis vertical hobbing platform with an integrated chamfering/deburring station to perform the new Chamfer Hobbing process in parallel to hobbing, and thus achieving cycle times required for double clutch or eDrive transmission gears. The 160HCD incorporates several product improvements and, most importantly, adds a high-speed, 2-position CNC-gantry for efficient and fast workpiece loading.

This NC gantry loading system connects the hobbing station with the Chamfer Hobbing unit and the parts conveyor. A pallet ring conveyor is standard, although other stocking systems or interfaces



Chamfer Hobbing process can produce a variety of highly desirable chamfer forms. Unlike chamfer rolling, however, it does not generate a secondary burr requiring removal downstream.



An optional Chamfer Hob head with outboard support accepts up to four Chamfer Hobs for two gears on a shaft or for non-standard gears.

to external automation can easily be applied.

The integrated Chamfer Hobbing unit employs an axis configuration similar to the main hobbing machine; all NC-controlled by the shared Siemens 840D sl control. The standard configuration of the Chamfer Hobbing

unit contains a Chamfer Hob head with the capacity to mount two Chamfer Hobs. An optional Chamfer Hob head with outboard support accepts up to four Chamfer Hobs for non-standard gears. Alternatively, longer Chamfer Hobs could increase tool life per hob and decrease unproductive tool changes. Chamfer

# Chamfer Hobbing

Integrated chamfering/deburring station performs Chamfer Hobbing in parallel to gear hobbing. A high speed 2-position gantry loads the workpiece for hobbing, transfers the workpiece to the chamfering station, and delivers the finished workpiece to the parts conveyor.

Hobs are mounted on a hob arbor with HSK interface to ensure accuracy and fast tool change. For shaft-type parts up to 380 mm in length, a tailstock is available at the hobbing position and in the Chamfer Hob unit.

The ability to machine economically in smaller batches is essential. Short tool change is one key element – workholding changeover is another. With Gleason's Quik-Flex® system the fixtures in both the hobbing and Chamfer Hobbing stations can be changed in under a minute each. While the expanding bushing and the base plate are the same for both operations the locating ring and fixture body are optimized for each process: rigid clamping close to the root diameter of the workpiece is chosen for high speed hobbing; slimmer fixture bodies with smaller location rings are preferred for more clearance below the

root diameter for root chamfering and achieving various chamfer angles.

Finally, the application of new GEMS® operating software greatly enhances the machine/operator interface. Data input is supported with interactive graphics that guide the operator through set up and changeover. The software interface also minimizes the learning period and wrong inputs.

## In Summary

Manufacturers now have a variety of chamfer/deburr options available, whether the proven chamfer rolling process for shortest cycle times, Chamfer Contour Milling for highest flexibility, and now Chamfer Hobbing, for medium to high volume production, producing chamfer forms to customer



standards, and with low tool cost-per-part. Depending on the specific requirements it is very likely that one of Gleason's chamfer technologies will address the varying challenges customers may have.



160HCD, latest addition to the Genesis family of hobbing machines, now adds new Chamfer Hobbing process to integrated chamfering and deburring options.



**Gottfried Klein**

Director of Product Management Hobbing, Chamfering and Shaving  
Gleason Corporation

# Combi Honing eDrive Gears

Hard finishing of synchronized stepped pinions for eDrive transmission applications now can be done to the tightest tolerances and highest quality standards with Combi Honing™.



As the automotive industry moves toward e-mobility, transmission manufacturers are faced with new challenges. Larger gear ratios are necessary to reduce the high input speeds of electric motors to the required speed of the drive wheels. At the same time, gear noise that was concealed by the sound of a combustion engine is now evident, presenting completely new challenges for acceptable

transmission noise levels. Finally, there are the special requirements to consider for the various new transmissions developed specifically for eDrive application. A common solution for eDrive transmissions are planetary transmissions using "stepped pinions", as shown in Fig. 1.

In specific planetary gear applications (Fig. 1), the two gears on the stepped

pinion are synchronized to fulfill an exact timing within very tight tolerances.

Due to the noise sensitivity of such components, hard finishing by grinding or honing is indispensable. Gear honing proves to be particularly advantageous, since honed components have a proven lower noise behavior than ground components due to their specific, curved surface structure. Gear honing

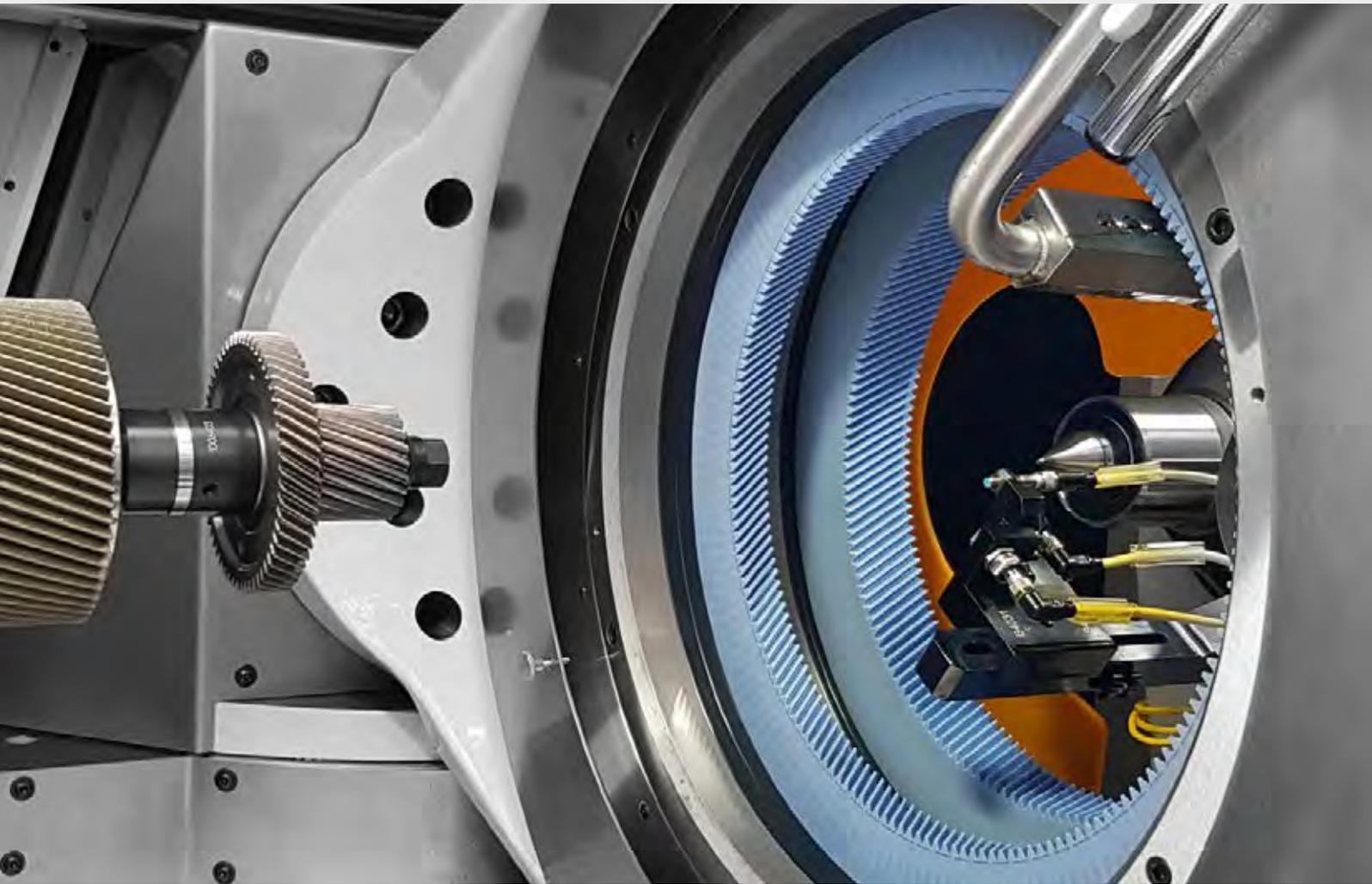


Figure 2: 260HMS can apply the Combi Honing process to produce stepped pinions reliably and at the quality levels needed to ensure the correct installation position in the planetary transmission. Integrated sensors measure the position of all teeth on both gear as well as the position of the index hole on the face side.



is also a requirement for machining gears with interfering contours, as is the case with stepped pinions. This is due to the small cross axis angle between the honing tool and the component and the fact that, unlike grinding, no tool overrun paths are required.

Figure 1: Planetary transmission with stepped pinions.

## Combi Honing, New Possibilities

With the acquisition of the Faessler gear honing business, Gleason has added a unique process to its gear hard finishing portfolio that makes it possible to hone synchronized stepped pinions in one clamping with extremely tight tolerances and the highest quality. This so-called Combi Honing system uses two honing rings. The honing head of a Gleason 260HMS Honing Machine (Fig. 2), for

example, can clamp two honing rings in parallel. The resulting eccentric offset of the honing rings is compensated for with a B-axis (swivel axis). In addition, flank line modifications such as crowning can be realized with the B-axis during the honing process.

The Combi Honing process starts with honing ring 1 honing the larger gear, and then honing ring 2 honing the smaller gear, all in the same clamping. Although this may sound trivial, this process has decisive and unique advantages, especially with regard to finished quality. While this specific component could also be machined in two separate set-ups, e.g. grinding the larger gear and honing the smaller one, the quality of the

resulting gear would not be the same, particularly the angular synchronization of both gears. When finishing both gears in one clamping, non-productive time for loading/unloading as well as indexing (centering tools and gears) occurs only once and not twice per component.

The Combi Honing Process on the 260HMS was specially developed for synchronized stepped pinion applications. A particular challenge was achieving the reliable and accurate positioning of the synchronized gears in relation to the honing rings. When indexing, i.e. centering gear teeth and tools, both teeth of the large and the small gear must be detected while corresponding exactly to the required

angular offset and the tolerances of the index hole on the face side of the gear. The latter guarantees the final correct installation position of the stepped pinion in the planetary transmission. Three indexing sensors (Fig. 2, right hand side of the picture) are used to measure the position of all teeth of the large and small gear as well as the position of the index hole on the face side. A corresponding algorithm calculates the correct position of the gear teeth in relation to the honing rings. Parts with excessive hardening distortions, which can't be honed in exact tolerances to the index bore, are automatically ejected.

Another important feature determining quality is the fixed position of the two

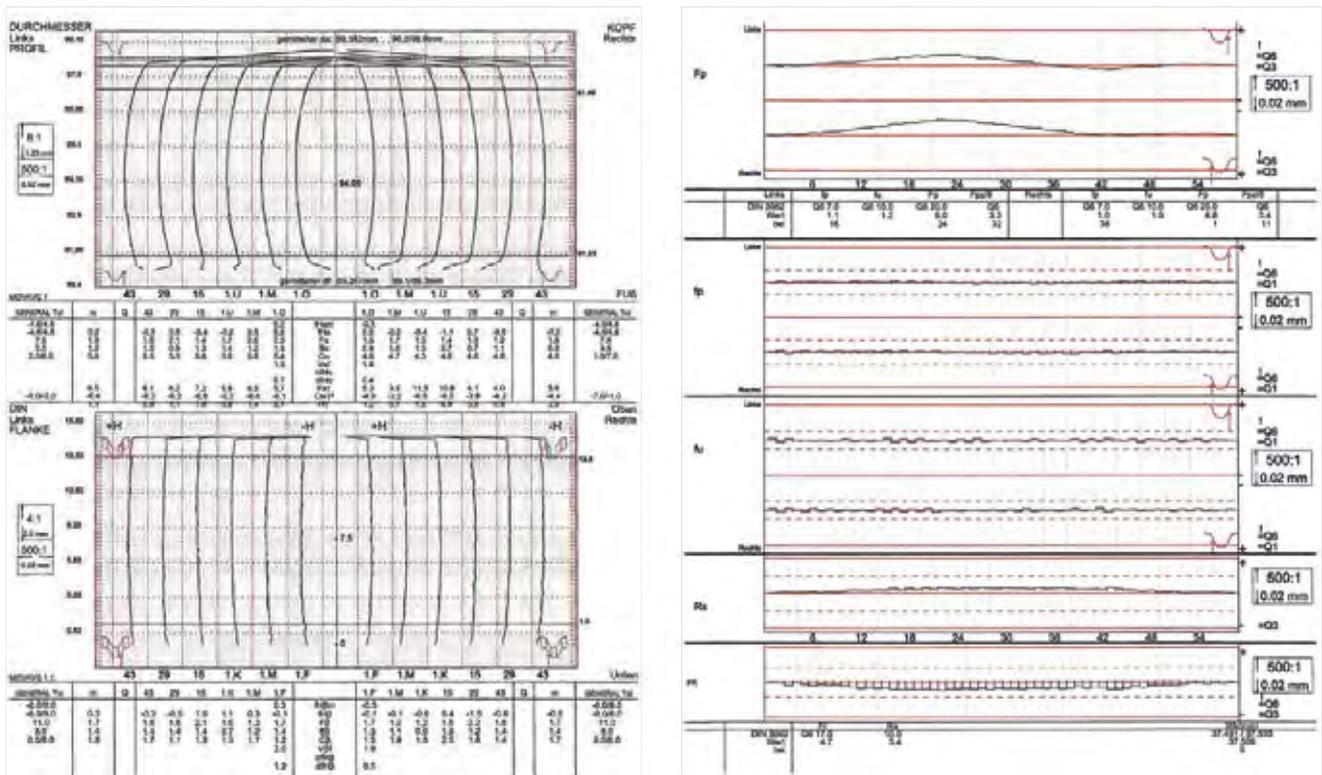
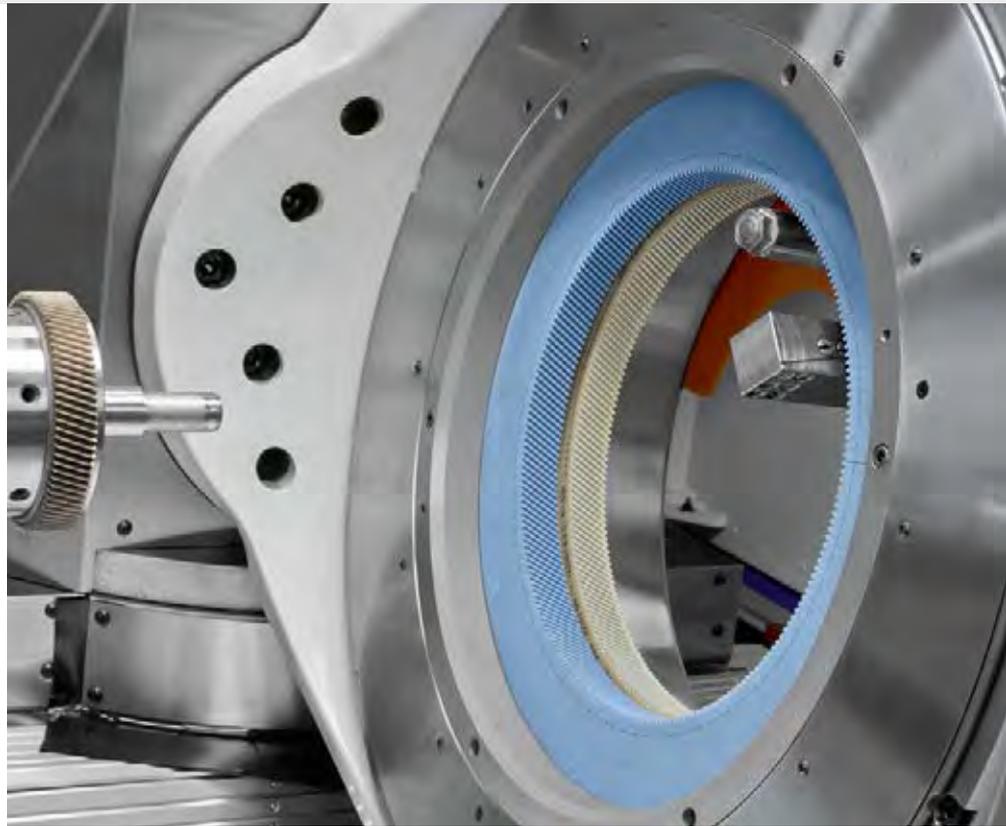


Figure 3: Quality of the larger gear on a stepped pinion, shown to be achieving DIN 5 or better.

Figure 4: Super finishing by Polish Honing can now be done with Combi Honing, and using two honing rings for rough finishing and polishing of a gear.



diamond dressing tools on the work spindle (Fig. 2). The location of the dressing tools ensures that the position of the teeth on the honing rings does not change either absolutely or relatively – even after dressing of the honing rings. Loading/unloading of dressing tools to the work spindle, as is often the case in other honing applications, cannot reliably achieve this important quality aspect.

For example, Fig. 3 shows the gear quality achieved on the larger of two sample pinion gears. Profile, lead, pitch and concentricity show excellent values in the range of quality DIN 5 and better. The required synchronization (timing) of both gears required relative to each other within tolerance of  $5 \mu\text{m}$  is reliably achieved within less than  $2 \mu\text{m}$  and represents a true breakthrough regarding the quality of such parts.

## Polish Honing for Better Performance

Another advantage of the Combi Honing process is the possibility of super finishing gears with "Polish Honing". The requirements for increased transmission efficiency and reduced noise levels demand a superior surface quality of hard-finished components. While Polish Grinding using a two-zone polish grinding worm is a proven approach, a similar process has not, until now, been possible with gear honing.

With Combi Honing, however, it is now possible to use two honing rings in one clamping and thus use two completely different tool specifications for rough finishing and polishing of a gear (see Fig. 4). This makes it possible to achieve the surface qualities of  $R_z \leq 1$

$\mu\text{m}$  typically required for polish grinding by means of gear honing – but with the added benefit of achieving the surface structures typical for the gear honing process.



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# New Tools for Noise Analysis

Today, powerful new gear noise analysis solutions are available to help in the quest to put quiet into Electric Vehicles.

In the design phase, proper kinematic and geometric gear design, along with the modeling of gear systems using new software tools, is helping to minimize gear noise downstream. In the manufacturing phase, tighter tolerances of many gear characteristics such as index, lead and profile errors, along with non-gear characteristics such as bearing surfaces and gear box housing dimensions, are also reducing noise.

In the final testing phase, traditional single-flank testers and dedicated test rigs have helped capture valuable noise-related data. However, the downside is that final noise quality is determined at or near the end of the manufacturing process, with most of the manufacturing costs already incurred.

With its latest generation of analytical inspection systems (GMS®, GMSP and GMSL series) Gleason provides a single platform to measure, control and provide data to optimize their gear manufacturing processes and control sources of gear noise. All GMS series machines use the very powerful, yet extremely easy to use, Windows-based GAMA™ software. Many proven analysis tools are built into GAMA. (Though the methods described in this article are mainly related to cylindrical gears, Gleason also provides similar solutions for bevel gears.)

## New Analysis Tools

Traditionally, gear measurement machines are used to inspect a few main characteristics on cylindrical gears: index, tooth size, lead and profile deviations. The many industry standards that exist globally explain how to measure these characteristics, as well as providing tolerances based on the class of gears.

While these traditional measurements and analysis outputs are very useful in maintaining gear quality, they do not provide in-depth, easy to interpret data for noise analysis. For this reason, GAMA is equipped with multiple analysis tools to help identify the root cause of gear noise. These include:

### 1. Fourier Analysis of Gear Measurements

Fourier analysis is the analysis of a complex waveform expressed as a series of sinusoidal functions, the frequencies of which form a harmonic series. Figure 1 shows Fourier analysis of index, lead and profile traces. By studying the harmonic values of standard traces, the noise behavior of the gear can be controlled. Figure 1 shows that amplitudes of lower harmonics (1st and 3rd) for index test are clearly beyond tolerance curve. Comparing individual harmonics values of a production gear with

a proven reference gear, the quality of produced gears is easily controlled. This analysis is combined with the traditional gear inspection data already provided, so no additional testing time is required.

### Fourier Analysis of Bearing Surfaces

In recent years, Fourier Analysis of Bearing Surface waviness has proven to be a very powerful tool in determining one of the main causes of low-frequency noise in a gear box. GAMA is equipped with Fourier analysis of bearing surfaces as well. Typically standard journal measurement charts can only assist with finding lower harmonic issues caused due to eccentricity. By applying Fourier analysis to measured journals, one can focus on higher harmonics as well.

### 2. Tooth Contact Analysis

While waviness analyses are very useful for analyzing individual gears for quality control, in real life, gears

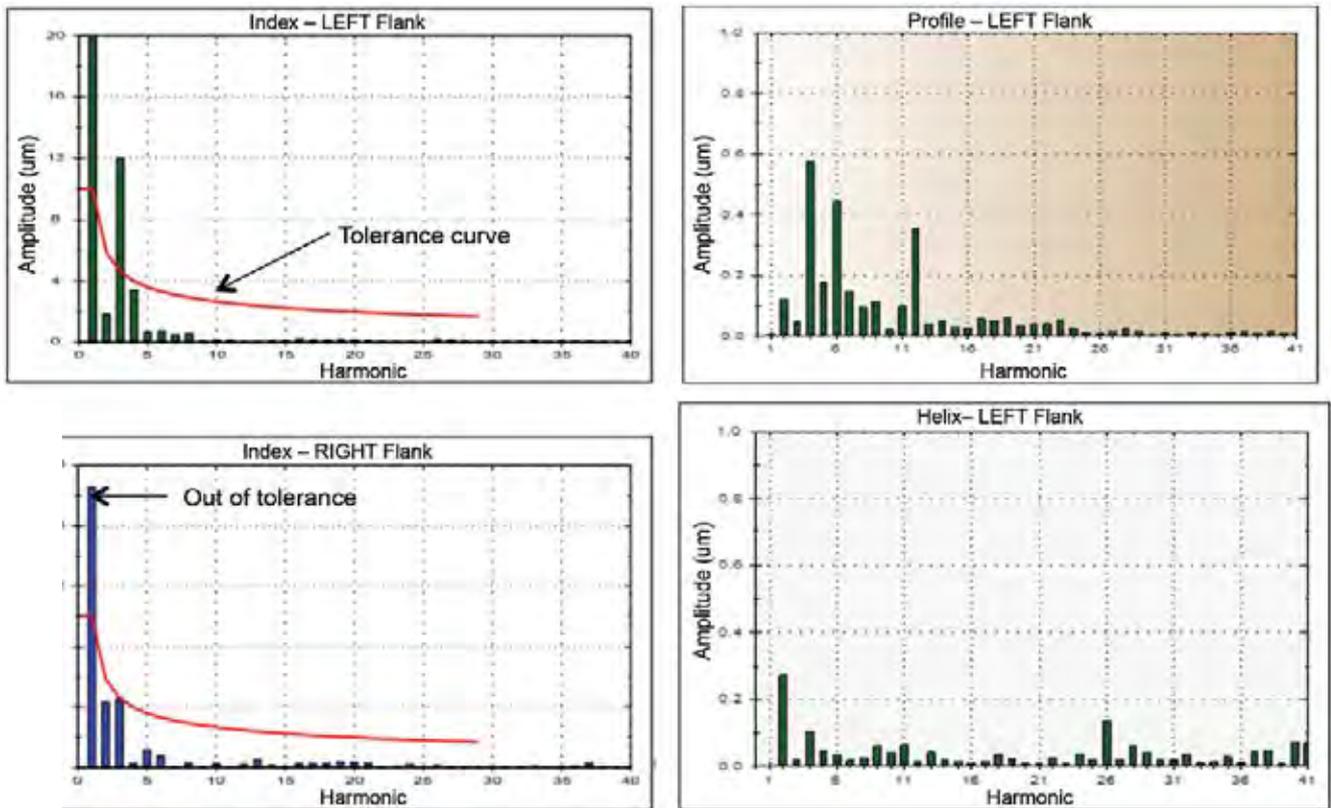


Figure 1: Fourier analysis of Index, Profile (Involute) and Helix (Lead).

are always meshed in pairs to transmit motion. The true performance of a gear is determined when it meshes with a pinion.

Over the years, gear researchers have developed mathematical models to analyze the meshing of gear pairs. These models assist in the design phase of a gear pair, targeted to minimize transmission error and improve

contact pattern on the gear surface. Transmission error is the difference between the actual position of the output gear and the position it would occupy if the gears were perfectly conjugate.

GAMA can also provide valuable information to the user by mathematically meshing the surfaces of the gear and pinion, which is extremely useful in design as well as in all production

phases of the gear. A topological inspection of the mating area of the gear and pinion is performed. This data is then input into the GAMA contact analysis software to compute transmission error along the meshing path and generate ease-off topographical charts. The software is capable of reviewing the effect of misalignments in the axial and radial directions. This allows design engineers to modify gear surface geometry such as amount and length of tip relief. The mathematical algorithms are optimized to give these results in a few seconds on GMS machines.

Figure 2 shows the interface for GAMA Tooth Contact Analysis. The user can easily select inspection data from a previously inspected gear and mating pinion, and analyze them with a single click.

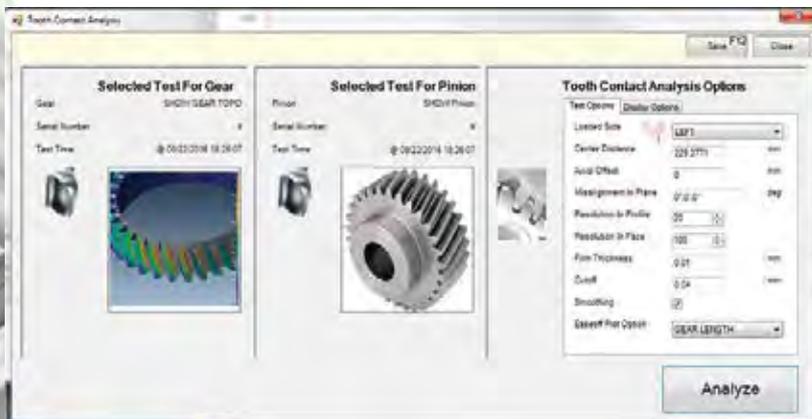


Figure 2: GAMA Tooth Contact Analysis Interface.

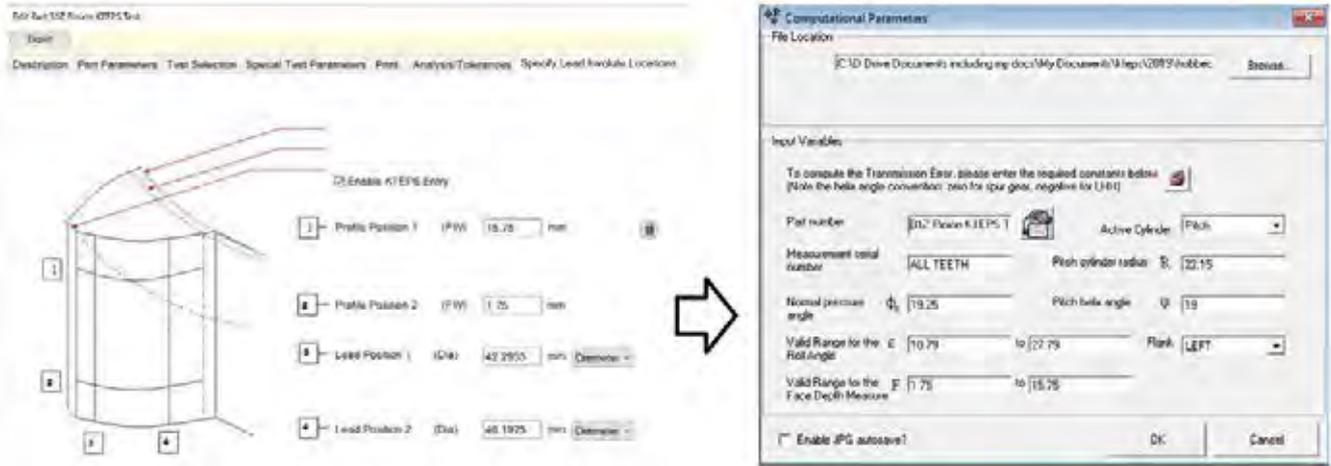


Figure 3: GAMA KTEPS Integration.

The GMS, GMSP and GMSL are all capable of performing contact analysis, with the same GAMA software. However, the GMSL, with its non-contact laser sensor, can make an 800% cycle time reduction as compared to inspecting the same gear with a traditional touch probe.

The GMSL also has the ability to take multiple complex sections on a 3D point cloud generated by a non-contact sensor. GAMA can take these sections along the path of contact, and export them for transmission error analysis.

### 3. Surface Finish Analysis

While waviness and contact analysis are very useful in controlling gear pair-related noise issues, surface finish inspection has a direct impact on the higher frequency noise behavior of gear sets. Surface finish also has a proven impact on the life of a gear. Surface finish measurement on manual surface finish inspection machines is a very complex and time-consuming process. This has been made easier on GMS series machines with integrated, surface finish probing technologies and GAMA software. GAMA provides a very powerful analysis package, which can measure up to 72 different surface

finish characteristics with advanced filter methods to analyze high-frequency noise.

### 4. GAMA and Kinematic Transmission Error Prediction Software (KTEPS).

KTEPS uses a revolutionary analysis approach for determining and diagnosing gear noise especially related to ghost noise. Ghost noise in a gear pair is much more complex to analyze than mesh harmonic noise. The unique one-to-one correlation of gear performance in the time and frequency domains to the geometric and kinematic contributions to transmission error from the tooth face geometry of a single gear allows the software to break out tones and the harmonic nature of gear noise in ways that no other analyses can match. Simple error amplitude metrics do not correlate well with the noise generating properties of harmonic errors, but KTEPS is able to generate the unique error pattern on any portion of any gear tooth responsible for a particular noise harmonic, whether or not it is associated with a mesh harmonic.

The GAMA interface directly communicates with KTEPS in a

much-simplified user interface as shown in Figure 3. All programmed geometrical and test data such as inspection locations is transferred automatically from GAMA to KTEPS at the end of test. GAMA's unique ability to communicate with KTEPS in the background puts this easy-to-use interface at your fingertips on GMS machines.

Figure 4 to 6 shows example analysis of 31 teeth pinion in KTEPS. All teeth of the example gear are inspected at multiple lead and profile locations.

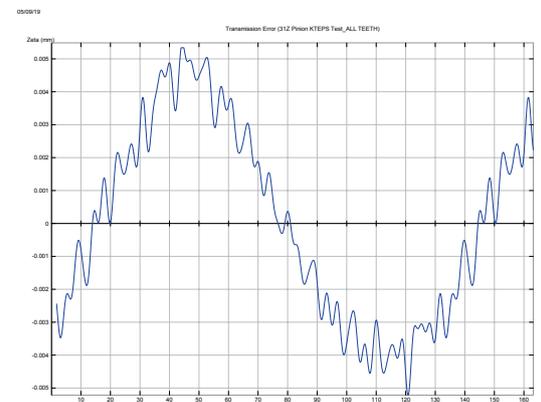


Figure 4: Transmission error of all teeth inspection

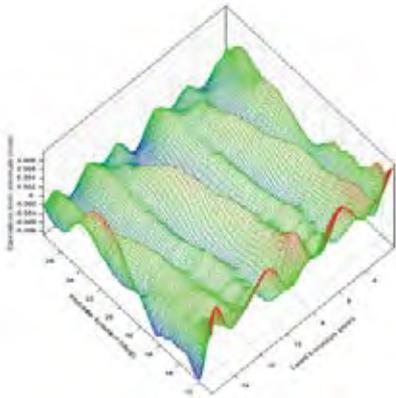


Figure 6A: Reconstruction of tooth topological form for 1st harmonic.

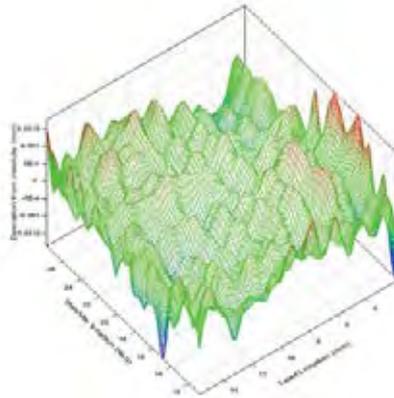


Figure 6B: Reconstruction of tooth topological form for 19th harmonic.

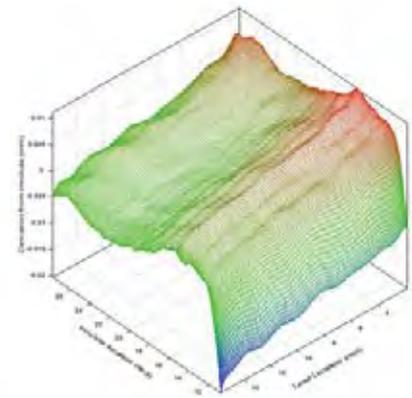


Figure 6C: Reconstruction of tooth topological form for 31st harmonic.

Figure 4 shows transmission error analysis for one full rotation of gear. Since example gear has index error, chart shows large sinusoidal error for one full rotation of gear. Each gear tooth shows varying transmission error as well. Figure 5 shows Fourier analysis of transmission error for same gear. Since this gear has 31 teeth, large transmission error amplitude is observed at 31st rotational harmonic. 1st rotational harmonic also shows large transmission error amplitude which correlated with large sinusoidal

error generated due to index error shown in figure 4. Example gear has form error in lead direction generated due to hobbing operation. This has resulted in large errors around 19th rotational harmonic. One of the major strengths of KTEPS is its ability to swap between spatial and time domains with no approximations. Figure 6 shows reconstruction of tooth at different harmonic. By studying topographical chart at required rotational harmonic based on Fourier analysis gives user ability to relate gear noise with topological errors.

## 5. Loaded Contact Analysis

These GAMA built-in tools are very useful in helping control noise in both the design and production phase. However, for complete design, an engineer has to consider the effect of tooth bending under varying load, and understand the behavior of a gear pair under varying torques or loaded conditions. This is also known as loaded contact analysis.

Both the Loaded Distribution Package (LDP) developed by Ohio State University as well as Gleason KISSsoft software have the ability to perform this

analysis. GAMA is capable of writing gear inspection output files in a format that can be easily imported into OSU LDP. This is achieved by topographical inspection in GAMA, with a simple checkbox on the user interface. Using GAMA's Geanet ability, the user can control the storage location of such files for ease of use by a design expert at his offline workstation. GAMA is also capable of writing gear part parameters including tolerances and inspection test data in xml file format published by VDI/VDE 2610 GDE standard. This data then can be shared with KISSsoft for both gear and gearbox design optimization purposes.

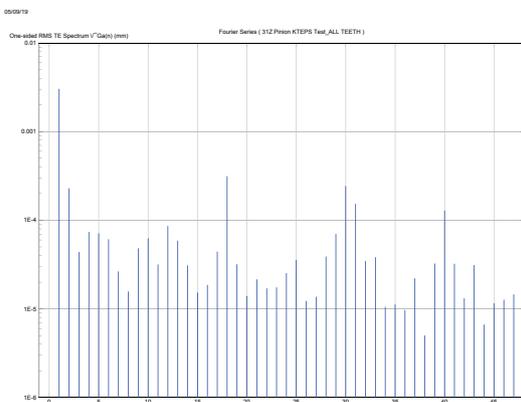


Figure 5: Fourier Analysis of transmission error



**Parag Wagaj**  
Director of Software Engineering and Technology  
Gleason Metrology Systems

**Douglas Beerck**  
Vice President and General Manager  
Gleason Metrology Systems



# MERCURY

## Goes Boldly

Marine propulsion leader Mercury Marine is putting the throttle down, going faster, further with new Gleason technologies.

A new generation of hard-charging, quiet-running Mercury Outboards are redefining the category. You'll find these new 'MerCs' everywhere, from sports fishing to speed boats, pontoons to pleasure craft, on inland waters and the high seas.

*Go Boldly* is both the company's tagline and its mission. Mercury is surging ahead in the \$4 billion global outboard market, powered by the most ambitious new product launch effort in the company's storied history. At the company's Fond du Lac, Wisconsin

headquarters, the 375,000 sq. ft. Plant 4 is 'ground zero' for the production of all the critical gears and shaft components used in these new engines.

# Bevel Gear Manufacturing



Mercury Marine applies new Gleason manufacturing and inspection technologies to produce the quiet, reliable bevel gears and pinions that help propel a new generation of high-horsepower outboards.

### Quality Lab Gears Up

Not surprisingly, Plant 4's Quality Lab has never been busier, running 24/7 and dividing its time between supporting new gear development efforts and meeting the needs of daily gear production. It's a heavy workload, acknowledges Mercury Quality Manager J.P. Wilke, but one he and his quality department began gearing up for several years ago with two Gleason 475GMS Analytical Gear Inspection Systems.

"We saw that the inspection equipment we had in the lab would be inadequate

to meet anticipated demand," recalls Wilke. "Some of our older inspection machines were no longer supported, and with 12 different programming languages at work, it was tough finding people with the expertise to run them. The Gleason machines have changed all that."

The two Gleason 475GMS systems enabled Wilke to replace his outdated machines and all but eliminate the need for special expertise in a variety of programming languages. What might have taken as long as 22 minutes to inspect a driveshaft over multiple

machines now can be done in as little as seven minutes on a 475GMS, says Wilke, using GMS' powerful and easy-to-use GAMA software.

"Anything from a half-dollar size pinion to a three foot long drive shaft, we're ready on a moment's notice," says Wilke. "The common denominator is quality. The GMS machines enable us to support any requirement, whether helping optimize contact patterns to eliminate gear noise, or automating corrections in a matter of minutes for a new part run on the Gleason production machines."

### The Rise of Phoenix®

Gleason's GEMS Bevel Gear Engineering and Manufacturing System seamlessly connects GMS to four

Two new Gleason 475GMS inspection systems have replaced multiple outdated machines to speed and simplify inspection, and link seamlessly to Gleason cutting and grinding machines.



new Gleason Phoenix® 280C Bevel Gear Cutting Machines, now doing the work that once required some 40 Gleason manual machines. The ability to make automatic corrections and start producing parts within minutes of receiving a new summary is just one of the many rewards that Mercury is reaping with the 280Cs, says Mercury Manufacturing Engineer Ben Prevost. "On the manual machines, we'd allocate a complete shift just to change from one part to another," he explains. "With the 280Cs, there's no manual guesswork. The whole process takes about an hour."

The 280Cs deliver cycle times about 50% faster than the manual machines, with load/unload time greatly reduced through use of Gleason Automation Systems' DS1200. This machine tool loader stores and conveys parts in stackable trays, allowing the load and unload of dozens of parts at a time. Compared to conveyor systems, the DS1200s put three to six times more parts in-process, thus freeing up the machine operator to do more productive things.



Four Gleason 280Cs now do the work of some 40 manual machines, cutting part changeover time from a complete shift to around an hour.

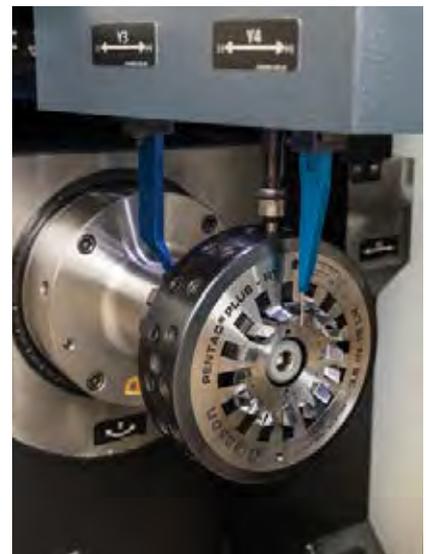
### Automated Cutter Build

The 280Cs run the latest Gleason Pentac®Plus-RT cutter systems, with carbide blades coated in AICroNite®Pro, to produce as many as 1,500 parts between blade re-sharpenings as compared to just 70 parts or so per

sharpening using solid body cutters on the old manual machines. When it comes time to build a cutter head, a new Gleason 500CB Cutter Build Inspection Machine takes most of the time and effort out of the process. After cutter build data is input, the operator loads

the cutter head, positions the work build carriage, and loads the blades into their respective slots. Next step? Press GO and walk away, with 30 minutes or so now available for other tool room tasks.

Gleason 500CB automates the cutter build process for the Pentac®Plus cutter systems used on the 280Cs.



# Bevel Gear Manufacturing



Each 280C has a Gleason DS1200 Machine Tool Loader, which uses a stackable tray system and robot to automate part load/unload. The automation uses less floor space, and puts more parts in-process, than conveyor systems.

### More Grinding Capacity

Mercury Marine finish grinds its gears as a final step to ensure a quiet, reliable gear mesh. To meet demand, grinding capacity was greatly expanded with the addition of a Gleason Phoenix® 280G Gear Grinding Machine. “The 280G is larger and faster than our existing Gleason 200G and 275G machines and has eliminated the ‘choke point’ in our grinding operation,” says Ben Prevost.

“Changeover only takes about 30 to 45 minutes, thanks to a quick-change grinding wheel spindle, workholding arbor and coolant headers.”

On-board dressing and stock division also take precious time out of dressing the wheel between the rough and finish grinding passes, adds Prevost.

### Mercury Marine

Headquartered in Fond du Lac, WI, Mercury Marine is a \$3 billion division of Brunswick Corporation (NYSE: BC), and a world leading manufacturer of marine propulsion systems.

[mercurymarine.com](http://mercurymarine.com)

Mercury Marine has added significant new capacity to its finish grinding operations with a Gleason 280G, which also connects to GMS inspection via GEMS to automate the correction process.



# Get a Grip

Gleason's new Modular Standard Workholding puts the performance benefits of tool-less quick-change workholding into a system of standard, interchangeable, and readily available modules.

**G**ear manufacturers are meeting fast-changing customer demand with smaller batch sizes requiring frequent part changeover. Traditional workholding taking 20 or 30 minutes for changeover and considerable operator experience are giving way to quick-change alternatives. These new solutions can be installed and removed in just seconds, with only a single tool, and by even a novice.

Benefits such as increased spindle time, more productivity and lower cost per workpiece are readily apparent for users of this latest generation of workholding. Gleason's Quik-Flex® and Quik-Flex®Plus systems, for example, have revolutionized workholding changeover

for small and medium size cylindrical gears with a system of modules that can be installed on a base arbor permanently mounted in the work spindle with just the twist of an activation handle. (Quik-Flex is so simple and effective that even non-operator contestants in our tradeshow demonstration challenges have routinely removed and installed Quik-Flex in under 10 seconds.)



### The New Modular, Off-the-Shelf Standard

Today, introduction of a system of Modular Standard Workholding puts Quik-Flex performance into a system of small, medium and large standard interchangeable modules that span the most common range of gear diameters. If Quik-Flex results in shorter cycle times chip-to-chip, then Modular Standard Workholding does it one better: shorter 'ship'-to-chip time. Now, there's an in-stock, off-the-shelf solution available to users almost overnight to meet the latest workholding requirements of many of the most common cylindrical gear bore sizes and diameters. End result: elimination of many weeks of waiting, and the inherent cost, for special tooling whenever a new application arises. Instead, manufacturers can meet most, if not all, of their needs with any of a family of just eight standard modules covering bore diameters ranging from 18 mm to 100 mm.

Each module consists of an interchangeable clamping head connected to an interchangeable arbor body, both of which come in a variety of sizes to form a multitude of standard

combinations to fit the user's part-specific application requirements. These modules interface with just three sizes of Quik-Flex base adapter, permanently mounted in the work spindle. The base unit is designed to be fine-tuned during its installation for minimal axial and radial runout. Most importantly, the modules can be installed, and removed, in just seconds with just a quick twist of the system's simple, removable, activation handle. No other tools are required, nor any of the usual mounting bolts, set screws or ejector screws to deal with. Note that an internal cam locking mechanism built into the base ensures that modular colletting tooling is centered and drawn firmly against the seating face of the base.

Most importantly, Modular Standard Workholding makes no compromises on quality. Accuracies and repeatability of 5 microns (0.0002") TIR – identical to the other Gleason workholding – is guaranteed. It's also equipped with Gleason's 'New Blue' segmented collet, which delivers exceptional reliability over an extremely long life as well as a particularly wide expansion range of up to .50 mm (.019") for increased flexibility.

Finally, since customers are increasingly in need of the ability to track critical data, Gleason is incorporating 'Gleason 4.0' and gTools technology into its workholding. gTools gives users of Modular Standard Workholding the option to use RFID chips to, for example, determine how many times the workholding has cycled. Knowing this can help the customer to determine when preventive maintenance is required. It can also be used to trigger reorder points for wear parts such as collets.



# Hydraulic Workholding Takes Hold

New Gleason hydraulic workholding solutions are becoming an attractive alternative to traditional mechanical systems in an increasingly wide range of gear manufacturing applications.

In the brave new world of smart factories, Internet 4.0 and highly automated machines and cells, workholding rarely gets top billing, despite the profound impact it can have on reducing cycle times, scrap and, ultimately, cost per workpiece. Fortunately, most gear manufacturers have begun to take notice, as a new generation of these under-appreciated components doing the 'dirty work' prove their worth.

## The Flexibility of 'Fluids'

As awareness of workholding's importance has grown, so has customers' willingness to explore alternative clamping solutions. Hydraulically actuated workholding solutions for bores and shanks, for example, are now being

developed by Gleason for applications once considered strictly the domain of traditional mechanical clamping systems.

Most recently, Gleason has developed hydraulic workholding systems for applications ranging from hobbing automotive transmission gears in high volumes, to Power Skiving large internal gears, in lots of one or two, to high-precision hob sharpening operations. These systems are capable of performing as well or better than their mechanical counterparts. Most importantly, they offer a host of characteristics unique to hydraulic systems that are increasingly desirable. For example:

## More Flexibility

Hydraulic workholding offer attractive benefits to manufacturers producing

parts with various bore or shank diameters, and/or producing multiple parts in a stacked configuration. The new-design Gleason hydraulic production expanding arbor is available for, but not limited to, the most common size range of automotive cylindrical gears from 12 mm to 100 mm in diameter. It delivers a

(Left) Hydraulic arbor with long expansion sleeve, well suited for multi-stacking applications.

(Center) Hydraulic multi-stacking application.

(Right) Hydraulic arbor with long expansion sleeve, well suited for automotive planet pinion applications.



very powerful and consistent clamping force when hydraulic fluid pressure is applied to a thin-walled expansion sleeve, precision-machined out of tough tool steel. The sleeve expands as required by the application uniformly over its entire chucking length. This gives a single arbor the inherent flexibility to meet the requirements of a variety of parts with different bore diameters.

The ability to produce uniform clamping force across the entire length of a gear's bore also makes it an ideal solution for the machining of both thin-walled and multiple-stacked parts. In the case of multi-stacking applications, the sleeve can be designed with multiple expansion zones so that even parts with different diameters can be stacked together and clamped with great precision.

## Greater Reliability

These hydraulic workholding systems apply clamping forces in a completely enclosed system that's impervious to the contamination that can plague much more exposed mechanical systems. In high-volume, dry-cutting operations, the periodic downtime required for routine maintenance, cleaning and lubrication can be an enormous burden. The same problems exist in large-part production as well, and particularly so with internal gears where effective chip evacuation can prove more difficult.

Additionally, Gleason's use of new FEA design tools, precision machining and heat treat resources, and our extensive workholding 'know-how', have enabled us to manufacture hydraulic workholding for greater reliability and extreme accuracy. Our standard hydraulic production expanding arbors, for example, deliver the standard accuracy and repeatability levels – 5 microns (0.0002") TIR – of their mechanical counterparts, but can also be designed for applications where the quality bar is even higher.

Our hydraulic hob sharpening arbor is one such example. This type of high accuracy production arbor typically

has two expansion zones delivering an accuracy of .0013 mm (.00005") or better. In the case of a typical shell-style hob with two location bores with a relief between them, the arbor expands into the hob bore to clamp, leaving zero clearance. A typical mechanical system would require a small clearance, thereby compromising accuracy. Additionally, a mechanical system requires an axial clamping element, whereas the hydraulic system's very high bore clamping forces eliminate this need.

## Fast and Economical

Finally, hydraulic workholding can offer attractive economies. Meeting on-going new-part clamping requirements often requires production of new, high-precision mechanical collets that are both expensive and require lead times of many weeks or months. In the case of a large-part Power Skiving application, Gleason's hydraulic workholding system was the perfect solution to meet the needs of the customer's ambitious multi-part family production requirements. Just two large chucks, with adapting sleeves, accommodate a range of workpiece diameters from 200 to 400 mm. They can operate with less maintenance required as well, sealed against all the chips and swarf produced in this highly productive Power Skiving environment.



**Peter Harrison**  
Mechanical Engineer,  
Tooling Products  
The Gleason Works



Warn Automotive picks up speed. Gleason high-speed gear shaping and hobbing technologies help meet unprecedented demand for powertrain disconnect systems.



**4**WD vehicles have never been more in demand, from the off-road enthusiast taking on the challenges of the most inhospitable terrain, to the soccer mom transporting kids safely in a sudden torrential downpour. Yet, drivers on both ends of the performance spectrum increasingly want one thing in common: more efficiency. The ability for the vehicle to switch effortlessly between rugged four- , to efficient two-wheel drive delivers highly desirable fuel savings, extended range and smaller carbon footprint. Seamlessly re-engaging 4-wheel drive when the terrain calls for more traction ensures safety and the full 4x4 experience.

Helping achieve the best of both these worlds in some of today's hottest selling 4WD light duty trucks is a patented new Warn Automotive high-speed front axle disconnect system. But you'd never know it's there. Nothing works faster or more smoothly to disconnect the front axle from the drivetrain when not needed, and immediately re-engage it when a wheel slips or the vehicle encounters a sudden steep grade. Warn Auto, whose mission for 70 years has been to create products that 'take vehicles further and bring them back again', simply builds a better disconnect mousetrap. At the heart of this mousetrap are a high-precision gear shaft and its drive spline mating part that ensure that disconnect/connect come off without a hitch over the course of many millions of duty cycles. When Warn Auto Senior Manufacturing Engineer John Bavarskas and his team were tasked with figuring out how to produce these precision gears most efficiently in increasingly high volumes, he suspected



First 100S installation in North America delivers unprecedented chip-to-chip times with 3,000 stroke per minute speed.

that conventional gear production technology just wouldn't cut it.

### **Faster Shaping Arrives in North America**

"Originally, we weren't planning on shaping the OD on the drive spline," recalls Bavarskas. "Our intent was to pot broach it. Then our design team challenged manufacturing to find a way to produce the drive spline so it could accommodate a much less expensive off-the-shelf ball bearing with larger ID. However, increasing the drive spline bearing surface diameter accordingly made it impossible to broach, hob or even skive without nicking the bearing surface. We prototyped the part on an older gear shaper and it worked, but it was painfully slow. We met with Gleason and they said they had the perfect high-speed shaper solution: the

new 100S, just becoming available in Europe. They produced some beautiful sample parts that were rough and finish shaped with the desired cycle time, and to ANSI Class 4. We subsequently made history with the first 100S installation in North America. We've now got two and one more on order to meet increased demand. They are very fast, and rock solid."

Gleason's new website calls the 100S 'the sprinter', ideally suited for shaping spur and helical gears, internal and external, crowned and tapered gears and gears with particularly small face widths – all at up to 3,000 strokes per minute. Chip-to-chip times are under six seconds, and workpiece change times are under three seconds, thanks to a very high speed 2-station workpiece changing system.

The extremely compact and very robust design, in combination with a twin-bearing crankshaft, guarantees a statically and dynamically rigid machine – critically important when dealing with the potential for vibration caused by these extremely fast movements.

Bavarskas also cites flexibility as yet another factor that weighed heavily in the 100S' favor. "If broaching had been an option, it would have been faster, but the savings using an off-the-shelf ball bearing more than made up for it. Plus, you don't get any size adjustment on a broaching machine," explains Bavarskas. "On the 100S, we can do size adjustments on the fly. However, we've designed these parts so that, even OEM to OEM, we're not changing stroke length or cutter, just a fast collet changeover with Gleason quick-change workholding to accommodate a slightly different bore diameter."

#### **P90, Perfect Fit**

In the Warn disconnect system, the drive spline with shaped OD gear mates with a 400 mm long, 65 mm in diameter shaft requiring the hobbing of the OD gear profile. These chrome moly 4140 shafts are first 'normalized' to the required hardness and then arrive as a near net shape forging at one of two

new Gleason P90 Horizontal Hobbing Machines, with one more on order. Five days a week, three shifts a day, each of these P90s produces a shaft to ANSI Class 5 standards every 60 seconds.

The decision to purchase the P90s was a little simpler, and perhaps more obvious, than the 100S, says Bavarskas. "The shaft is a bit too long for anything but a larger vertical hobber, and the automation on a vertical really isn't conducive because the workpiece would have to be turned 90 degrees from incoming automation," says Bavarskas. "The P90 with its horizontal bed and pitch speed automation feed conveyor lent itself perfectly to our manufacturing workflow. Plus, when we reached out to one of our OEM customers using Gleason P60s and P90s to produce their own gears we got a very positive thumbs up."

The P90 has been optimized for the mass production of shafts up to 500 mm in length (an axial slide travel of 400 mm can be increased to even 800 mm as an option), as well as other parts such as planetary pinions and sun gears with diameters up to 100 mm and module 3 – and all with the shortest possible cycle times. It features a direct-driven hob head operating at speeds of up to 12,000 rpm, with high-speed gantry loader to automate load/unload directly from the conveyor.

It's important to note, too, that this line of Gleason horizontal hobbers is the most versatile in the industry, with model variations for everything from integrated chamfer/deburring, to the production of particularly long shafts, to meeting the special requirements of worms and pump gears.

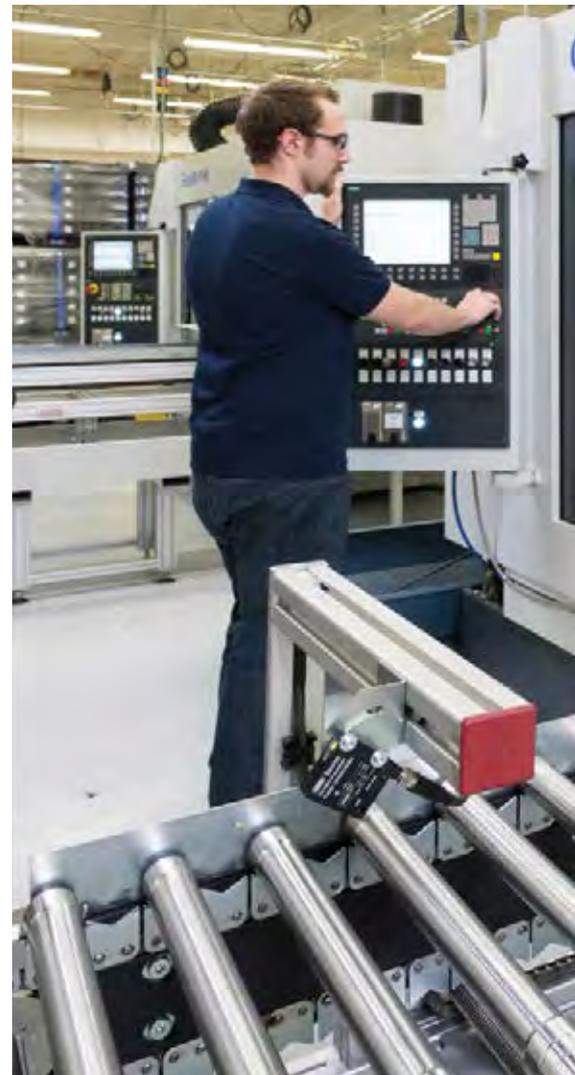
#### **Service, Above All**

"Gleason customer service is unbelievable," concludes Bavarskas. "As an example, we have an older Gleason Phoenix® 125GH Hobber that went down

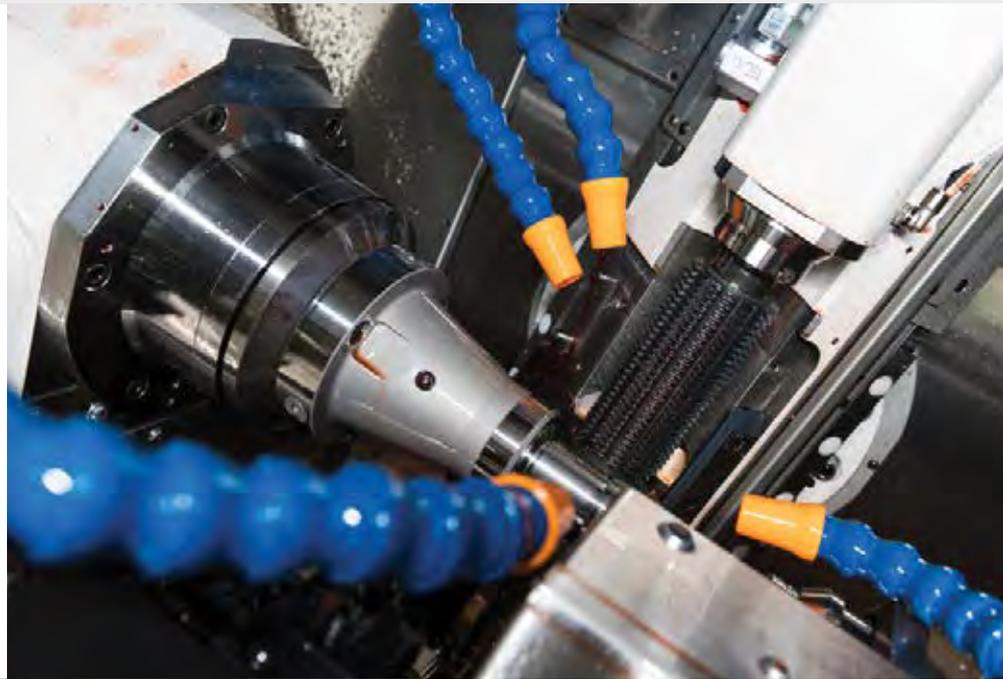
“ Gleason customer service is unbelievable. This is a big differentiator. There are other good machines out there, but Gleason service is unmatched.

John Bavarskas, Warn Auto Services Manufacturing Engineer

”



on a Friday. I called, sent pictures and Monday morning before our receptionist got here there was a Gleason service rep. waiting for the doors to open with the parts to fix it. We've got local CNC lathe manufacturers that can't provide service like that. The Gleason installation techs are just 'top drawer' too. Getting the new machines set up, training our operators, I can't stress that enough. This is a big differentiator. There are other good machines out there, but Gleason service is unmatched."



## Warn Automotive

Operating from headquarters and manufacturing facility in Milwaukie, Oregon – with additional customer support from their Technical Center in Livonia, Michigan – the Warn Automotive team applies 70 years of proven expertise to create the highest quality Powertrain Disconnect products in the world.

Warn Automotive is a company of the Vehicle Service Group (VSG) within the Engineered Systems segment of Dover Corporation. Dover is a diversified global manufacturer with annual revenue of approximately \$7 billion. Warn Automotive, LLC is not affiliated with Warn Industries, Inc., which is a wholly owned subsidiary of LKQ Corporation.

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# SEW Eurodrive Speeds Throughput

New turnkey, 'off-the-shelf' Gleason 2700AR system automates larger-gear load/unload to speed throughput and optimize process flow.

For many gear manufacturers today, small batch sizes and frequent part changeovers are the rule rather than the exception. For large part producers, manually handling workpieces is particularly burdensome. Finding a fast, economical and reliable solution to automate this operation has never been more critical.

## **A New 'Standard' for Large-Parts Automation**

With a product portfolio that spans the complete range of gear solutions, Gleason has been keenly aware of the challenges that exist for manufacturers of all types of gears. At Gleason Automation Systems, we've worked hard to develop a turnkey load/unload automation solution that can

be seamlessly, and economically, integrated with both Gleason, and non-Gleason, bevel and cylindrical gear machines producing parts weighing upwards of 150 kg. In the new 2700AR loader, we've achieved that objective. Now, for the first time, an automation system exists that uses standard, off-the-shelf components to automate the handling of larger workpieces.



(Left) 2700AR in use at the SEW Eurodrive facility in Lyman, SC automates load/unload of larger bevel gears on a new Gleason 600HC Bevel Gear Cutting Machine, greatly reducing time and freeing up the operator for other tasks.

(Right) Vision system uses its light to illuminate the part and help identify it, then determine its orientation and position.

(Bottom Right) End-of-arm gripper tool with three Gleason-designed gripper fingers apply frictional forces to firmly, and accurately, grip the part. The gripper fingers accommodate a range of parts without changeover.



Benefits of the 2700AR to the customer are truly significant. A labor-intensive process that would typically take the operator three or four minutes to perform can now be completed in under two minutes using the 2700AR. The potential for human error resulting in product damage or misidentification of parts is eliminated, along with the possibility of operator injury that always exists when manually handling large parts. Now, the operator can be available for other tasks, while the 2700AR does all the heavy lifting.



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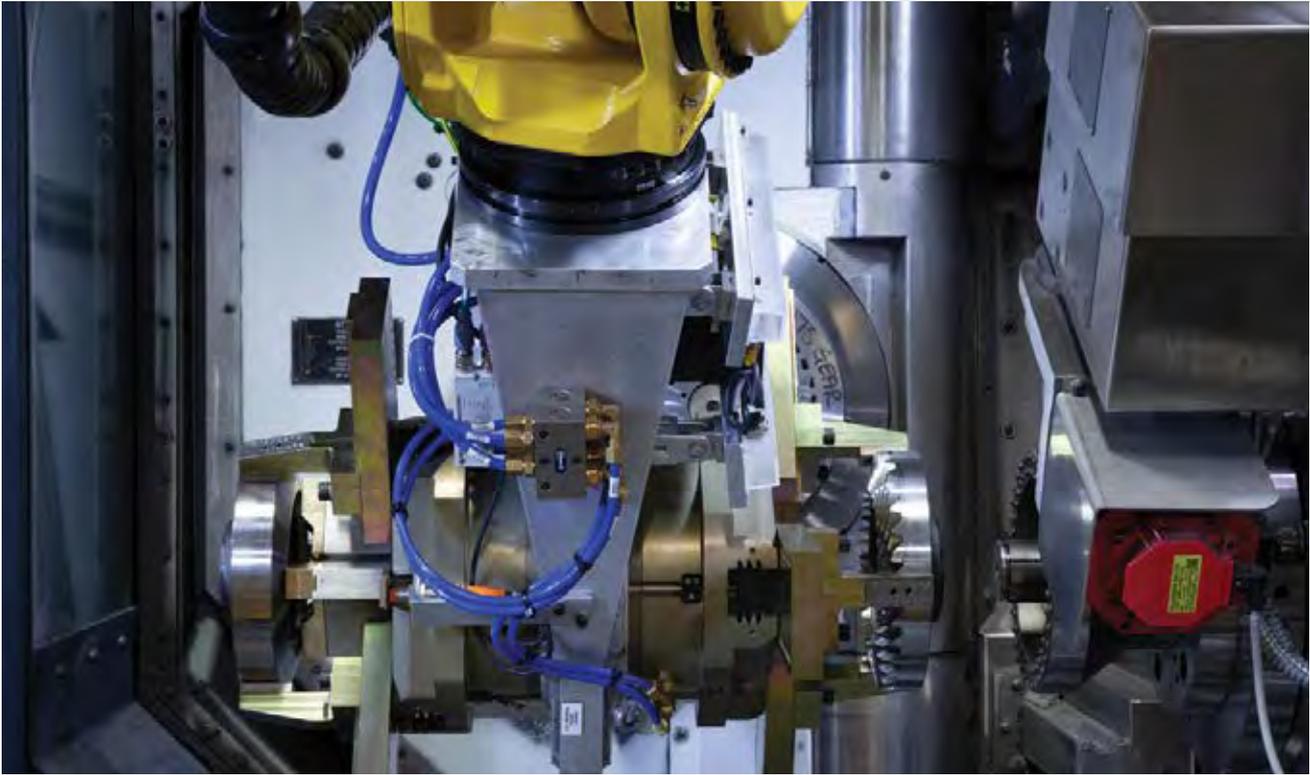
A labor-intensive process that would typically take the operator three or four minutes to perform can now be completed automatically in under two minutes.

Chuck Chandler,  
SEW Eurodrive Manufacturing  
Plant Manager

”

### Exceptional 'Plug and Play' Performance

In the past, achieving this automated capability would have required a customized solution only available to the customer at prohibitive cost. Now, through a combination of readily available robot and vision system components and Gleason Automation Systems 'know-how', the 2700AR is available as a 'plug-and-play' solution with truly remarkable capabilities. Here's how it works:



Double end-of-arm tool enables the robot to unload a cut part, rotate 180 degrees, and load an uncut blank, in just seconds.

Large-part blanks arrive at the machine on wooden pallets or plastic dunnage trays. Prior to picking up a gear blank a FANUC 6-axis robot uses FANUC 3DL Vision Guidance, consisting of camera and laser, to identify the part and establish its position and orientation. In this application, there are 14 possible parts, making accurate part identification critical. This system ensures that the robot can identify what part is being picked up, as well as being able to accurately grip the part to ensure proper orientation before loading it into the machine tool. If the system determines that the part is upside down, the part will be transported to a fixture where it can be placed and then re-gripped before transport to the machine tool in the correct orientation.

The end-of-arm tooling consists of multiple grippers. Each gripper has three Gleason-designed gripper fingers which apply frictional forces to grip the

part firmly and accurately. The gripper fingers accommodate a wide range of parts, saving changeover time. When necessary, the gripper fingers can easily be replaced.

If plastic trays are used for dunnage, when they become empty the robot gripper fingers pick and move them to the dunnage storage area. If plywood dividers are used, special end of arm tooling employs a vacuum head to pick the plywood divider sheets from the dunnage and store them in the dunnage storage area.

When the uncut blank is ready for transport to the machine tool, a network connecting the robot PLC and the machine CNC ensures that the robot/machine dialogue is intelligent. For example, the robot can tell the machine that it's ready to load a particular part number, rather than just a part. The machine tool can then determine if this particular part matches the summary

that it has prepared to run for that part. This greatly reduces the risk of time-wasting, scrap-producing errors.

The robot is equipped with multiple grippers for unloading and loading the machine tool. This allows the robot to unload a finished part with one gripper, swivel around and load a raw part with a second gripper, thus improving productivity. In addition, the robot can be used to transport parts to and from other secondary, post-machining operations.



**Christian Sterner**  
Chief Engineer  
Gleason Automation  
Systems

# Win-Win at VW Tianjin

Gleason Tool Management program helps Volkswagen Automatic Transmission (Tianjin) Co., Ltd (VWATJ) win prestigious VW Speed+ Award.

**G**leason provides customers worldwide with various Tool Management services according to their specific needs. This ranges from providing cutting tool sharpening services from Gleason's tool manufacturing plants or service centers, to full scale Tool Management services provided onsite at customer's place.

Among the most advanced of these Tool Management programs is what Gleason provides for Volkswagen Automatic Transmission (Tianjin) Co., Ltd (VWATJ) in Tianjin, China. Gleason Gear Technology (Suzhou) Co.,Ltd Tianjin Branch (GGTSTJ) was founded in 2013 to provide Tool Management onsite at the VWATJ plant. Today, close to 80 employees strong, GGTSTJ supports VWATJ in its production of six different gearbox types at two transmission gearbox plants (DQ&DL), 24/7.

The two main targets of our services are: managing cutting tool stock to fulfill production, and reducing cutting tool costs. The first objective requires ongoing monitoring of tool life in production, alignment of forecast with actual tool stocking and supplier lead times for tool replenishment. The daily operation covers stock in and out, delivery of tools to production, internal tool re-sharpening and preparation, outside tool coating, etc.

Helping the customer to save cutting tool costs is achieved through continuous improvement of tool life and improving process efficiency together with the supplier and production. Most important is identifying main cost contributors considering the whole manufacturing process chain.

Since 2013, GGTSTJ and its counterparts at VWATJ have managed to achieve continuous annual CPU savings for all projects in Tianjin plants.



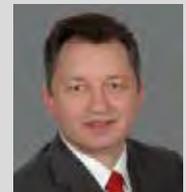
VWATJ management team wins a Speed+ Award (3rd Place) with the help of Gleason Tool Management.

With both parties' hard work, GGTSTJ helped VWATJ to reduce more than 10Mio RMB on tool cost in 2018.

For this excellent performance, VWATJ plant was honored with 3rd place in the "Speed+ Award" for tool cost category within Volkswagen Component Group globally. Congratulations, VWATJ colleagues!



**Michael Chen**  
Branch Manager,  
Gleason Gear  
Technology  
(Suzhou) Co., Ltd.  
Tianjin Branch



**Dr. Johannes Becker**  
Director & General  
Manager, Asia Tooling  
Operations  
Gleason Gear  
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Co., Ltd.

# Hard Racks Made Easy



Leading Japanese rack gear manufacturer Kousei Seimitsu raises quality and productivity to new levels with its Gleason 2000RMPH Rack Milling Machine.

**K**ousei Seimitsu (Kousei) specializes in making the hard look easy. As a leading Japanese manufacturer specializing in rack gears, Kousei produces racks for many industries, including machine tool, robotics, small industrial machines, and construction. But what gives them a true competitive edge is their mastery of the hard skiving process to produce hard (heat-treated) rack gears of the highest quality.

### Three Times Faster, a Quality Class Higher

Kousei recognized that it would need to find new technology if it were to meet fast-growing demand for high quality rack gears using the non-traditional hard skiving process. This new technology came in the form of a Gleason 2000RMPH, made in Japan by Gleason-Saikuni. Compared to

the company's existing conventional 2000RM machines (for soft rack milling), the 2000RMPH (for soft and hard rack milling) triples performance in terms of both cutter head power and maximum spindle speed, and delivers a dramatic productivity improvement in not only hard skiving but also soft rack cutting process.



Kousei President, Setsuhiro Usami says, “Gleason-Saikuni’s hard rack milling machine is a very good machine, maybe even better than Saikuni knows. Without this machine, it would not be possible to achieve the level of business we’re now experiencing.”

Today, Kousei Technical Director Masayuki Takagi says that the 2000RMPH is achieving surface roughness and pitch accuracy even higher than what a grinding machine can perform, and more than a class higher than what is actually required for conventional racks. “It took us time, and a lot of work to optimize tooling, to achieve these quality results, and to bring out what the machine is actually capable of,” Takagi, says.

### A Productive Partnership

Takagi also credits the close working relationship that has developed over the years between Kousei and Gleason-Saikuni as an important reason for the

success they’re experiencing with the new machine. Communications are vital, he says, to make design changes based on the actual voices of the workshop. Ultimately, this has resulted in a machine delivering higher performance, more user-friendly functions and higher precision to fit Kousei’s particular requirements.

Additionally, Gleason-Saikuni is upgrading Kousei’s existing 2000RM machines with 2000RMPH capabilities, and providing localized customer support to minimize machine downtime.

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“ Without this machine, it would not be possible to achieve the business we’re now experiencing.

Setsuhiro Usami,  
Kousei President

”



# Great Wall Powers Up

Gleason Power Skiving technology is helping China's largest manufacturer of SUVs meet record domestic demand, and its drive toward global markets.



Sports Utility vehicles (SUVs) accounted for almost 40% of total vehicle sales in China last year, up from just 6% a decade ago. You see them everywhere: Porsche Macans, X Series BMWs, Jeeps and, one of the hottest selling of them all – the Haval.

The Haval is the signature brand of Great Wall Motor Company, China's automotive powerhouse, a 60,000-employee company listed among China's Top 10 private companies and one of its 500 most valuable brands. Sales of its hot-selling Haval exceeded 750,000 in 2018, and while most of these are for the domestic

market, the company has its sights set on the global marketplace.

## Putting its Faith in Power Skiving

Great Wall Motor (GWM)'s strategy of what the company calls 'excessive investment' in technology R&D is at the very core of its success. A recent example is how the company approached the challenges of producing Dual Clutch Transmission (DCT) gears, and meeting demand for 1.2 million DCTs a year for the Haval and its other brand vehicles. The outer input shaft gears used in

this transmission couldn't be hobbled because of interference conditions. However, the company calculated that meeting these very high production volumes with the slower shaping process would require a prohibitively large investment in as many as 16 new shaping machines.

Fortunately, Gleason was able to demonstrate to GWM with actual test machining on its new 100PS Power Skiving Machine that the DCT application was ideal for the Power Skiving process, which is capable of delivering cycle times two to five times faster than shaping. Additionally, the 100PS, with its

(Top) GWM DCT facility produces over one million transmissions a year for hot-selling Haval SUVs.

(Middle) Six Gleason 100PS Power Skiving Machines are needed to produce critical outer input shaft for the Haval DCT, doing the work of 16 shaping machines.

(Bottom) With its horizontal-axis configuration, 100PS is ideally suited for shaft-type parts like the one shown in this example.



horizontal-axis arrangement, was shown to be particularly well-suited for shaft-type parts of the type being produced for the DCT.

Today, GWM needs just six Gleason 100PS Power Skiving Machines to meet the million plus capacity requirements for this critical DCT component, thus making significant savings in equipment, floorspace and energy costs. Company officials also say that Power Skiving cutter tool life between re-sharpenings far exceeds what would have been achieved with shaper cutters, helping greatly reduce cost per piece. Additionally, localized Gleason application expertise and cutting tool service and support are provided to the DCT facility in Baoding, Hebei Province from Gleason Gear Technology (Suzhou) Co. Ltd.



## Great Wall Motor Company

Great Wall Motor Company Limited is China's largest SUV and pickup manufacturer. For more information visit:

[www.gwm-global.com](http://www.gwm-global.com)

# DAVALL

An MTI Company

## Climbs Higher

British special gears manufacturer meets strong demand from aerospace and defense through modernization and investment in new Gleason technologies.

Davall Gears' acquisition in 2015 by MTI (a Steel Partner Company) – a leading developer of custom motion control solutions – has proven fortuitous. The high respected British custom gear producer is forecasting double-digit sales growth in 2019 and has MTI's support to add new manufacturing capabilities to fuel additional growth.

"Over the last several years, we've made significant investments to modernize our manufacturing programs and to optimize both our gear cutting and fine finish grinding processes, all of which has added speed, capacity and quality," says Davall Gears' Managing Director Simon Usher. "Most significantly, the new equipment invigorates our workforce. We can

attract and train young technicians and machine operators, and our more experienced workers welcome the chance to develop new skills. We also gain flexibility across the shop floor, since our operators can acquire the skills to run multiple new machines, most of which are Gleason."

### **P90G: One Machine, Many Benefits**

While Davall has a diverse product portfolio and produces gears for everything from medical devices to military vehicles to motorsports, it is particularly well known for aerospace gears – and the more challenging, the



## Grinding and Hobbing

better. When Davall's existing gear grinding machine couldn't reliably produce critical features on a high precision helical gear for a jet engine application, and still meet volume requirements they purchased a Gleason P90G Grinding and Hobbing Machine. The machine offered the high accuracy required to meet this and many of Davall's other precision aerospace applications and delivered a host of other benefits as well.

"Our Gleason P60 Horizontal Hobbing Machine has been very reliable, and the P90G does it one better: putting both hobbing and grinding on the same, proven platform, which was an attractive proposition," says Davall's Director of Engineering David Radley. "Coupled with the automation that's offered on this machine – we couldn't have found a better fit."

P90G puts hobbing and three types of grinding processes into a single, compact, efficient and highly automated package. Davall can run the machine unattended at night to meet the high volume requirements of a precision jet engine gear.



The P90G is capable of hobbing and grinding spur and helical gears and pinions up to module 3 mm and diameters up to 100 mm. It offers the user three different grinding methods to cover a wide range of applications:

- **Profile grinding**, using CBN profile grinding wheels shaped to suit the desired tooth form.
- **Threaded Wheel Grinding**, for higher volumes, using single or multi-thread CBN grinding worms.
- **Index generation grinding**, ideal for prototype work, using a module-independent CBN grinding wheel.

“While we’ve traditionally produced high precision gears of this type in relatively

low volumes, the P90G is doing over 2,000 gears a week,” says Radley. “It’s easy to set up and very dependable, so we can load up the automation and run the machine unattended at night, whether for hobbing or for grinding after heat treat.”

The P90G comes equipped with a very compact integrated gantry loader, and a continuous indexing chain belt with central lifting station for supplying blanks and discharging finished parts.

Radley says that the process of putting all this new technology in place was simplified by purchasing the P90G as “a complete kit”, including machine, automation, quick-change arbors and workholding, and carbide hobs (made

and resharpened by Gleason Cutting Tools GmbH in Eisenbach, Germany).

### The Importance of Support

Both Messrs. Radley and Usher credit the success of this new technology to Gleason’s support: installation and commissioning from the Gleason Sales UK office and extensive training from the respective Gleason production facilities in Studen, Switzerland (P90G), Ludwigsburg, Germany and Rochester, NY USA (280C). “With the help of Gleason, we’re entering a highly productive, very exciting new era at Davall,” concludes Usher. “We’re ready for what’s next.”

“ With the help of Gleason...we’re ready for what’s next.

Davall’s Managing Director Simon Usher

”



Davall sources highly productive carbide hobs with advanced AlCroNite® coating for the P90G from Gleason Cutting Tools GmbH, Eisenbach, Germany.

### Davall Gears

In 2015, Davall became part of MTI, a Steel Partners company. MTI is a an innovative, solutions-oriented manufacturer of motion technologies. Davall’s designing and manufacturing of precision gears, lead screws, universal joints and gearboxes enhances MTI’s ability to deliver innovative solutions to the aerospace, military, EV, medical and other industries. From within this platform, Davall now provides expertise in North America and delivers gear solutions to growing US markets.

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## A UK 'First'

### Installation of the UK's first Gleason Phoenix® 280C Bevel Gear Cutting Machine raises Coniflex® capacity and quality.

It seems that some things never get old. The straight bevel gearsets that Davall produces on its tried and true Gleason Coniflex® manual machines are in high demand, for use in the directional controls and actuators found in missiles and many other aerospace applications. But adding much-needed Coniflex capacity and higher quality required new Gleason technology, says Davall's David Radley.

"With our new Phoenix® 280C Bevel Gear Cutting Machine, we're producing these same straight bevel gears up to four times faster, with much higher feeds and speeds and greatly reduced part changeover times," says

Radley. "We can also run any of the hundreds of our existing cutters on the machine for legacy projects using the quick-change cutter adapters and workholding Gleason has provided."

Additionally, Phoenix's networking capabilities makes it simple for Davall to use Gleason G-AGE® correction software for fast and easy thickness, depth, pressure angle and spiral angle corrections and to eliminate much of the typical trial and error and potential for costly scrapped parts. "Our 280C gives us a highly productive platform with the versatility we need to take on a fast-expanding range of customer applications," concludes Radley. "In

addition to producing all types of face and straight bevel gears, the 280C can use the latest Gleason Pentac®Plus cutter systems to achieve extremely high speeds for face hobbing and face milling of spiral and hypoid gears. The end result is the exceptional productivity and quality that our customers are keen for."

(From left to right) Davall's Director of Engineering David Radley, Gleason's UK Regional Sales Manager Phil Perkin, and Davall's Managing Director Simon Usher.



# Gleason Cutting Tools Suzhou Celebrates its 10th Anniversary



On April 3, 2019, Gleason Cutting Tools Suzhou (GCTS), the tooling division of Gleason's China operation in Suzhou celebrated its 10-year anniversary. Touring the GCTS plant today, it is hard to believe that what started just 10 years earlier with a few employees in a small leased space has today become one of the most successful cutting tool producers in China.

The operation began modestly in 2009 with the manufacture of just HSS hobs. Shaper cutters and bevel gear cutting tools were added in 2010 and 2011. With GCTS' business growing rapidly, Gleason built its own new factory in Suzhou Industrial Park (SIP) in 2012. Since then the tool production portfolio and volume have continuously expanded. Today, 120 employees strong, GCTS designs, manufactures and services all kinds of cylindrical and bevel gear tools - for domestic and overseas markets; with volumes in the many thousands of cutting tools per year and production running 24/7.

As Gleason President and CEO John Perrotti said in his speech during the ceremony, "We have developed advanced abilities to design and manufacture high-precision tools with consistent quality and high customer satisfaction. Much of what we manufacture is for export to some of the most demanding customers in the world. This is a powerful statement about the performance of Gleason Suzhou and the team that is the engine behind those products."

Yu Yuanshuo, Vice General Manager at GCTS, reflected on the journey GCTS and its people took using photos and memory shots taken throughout the previous 10 years. "Watching how things have changed and improved, colleagues have developed on professional and personal level, set routes, grew families was very touching, funny and brought back good memories. On the other hand, it demonstrates the long journey GCTS has mastered so far and outlines the expectations for the future". As Dr. Johannes Becker, General Manager of GCTS, summarized it. "Starting as students in gear tool manufacturing, and having been trained by our colleagues overseas, we have become a full-fledged member of the Gleason Tooling Product Group. Therefore, the 10 year anniversary marks also the start of a new chapter in GCTS history."

As special guest, Bodo Mehrländer, General Manager of the Volkswagen Transmission Plant in Shanghai (VWTS) joined the event, having also participated in GCTS opening ceremony in 2009. Mehrländer stated he was pleased to see what GCTS has become and that his blessing words from 2009 "had been fruitful". He pointed out that quick response and delivery time of both - Gleason China machine and tool manufacturing operations, and their positive approach towards customer needs, have been essential factors in Gleason's good success in China.

**Happy 10th Anniversary GCTS!**

**Gleason**

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