Smart Gear Manufacturing as a Competitive Edge

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Vice President Worldwide Sales and Marketing
Gleason Corporation
Bevel Gear Manufacturing Solutions

Complete Bevel Gear Production Systems
Up to 2,500 mm in diameter

design  engineering & mfg  cutting  cutter build  reconditioning  5 axis  quenching

lapping  grinding  testing

metrology  automation  tools  workholding  application  services  training  plastic gears

versatile solutions
Cylindrical Gear Manufacturing Solutions

Complete Cylindrical Gear Production Systems up to 10,000 mm in workpiece diameter
Metrology Solutions

**GMSP Series** for Measuring on the Shopfloor

**GMSL** with Multisensor Technology including Full Form Scanning of Non-Gear Applications.

Analytical gear inspection for bevel gears, cylindrical gears, gear tools, rotors etc.

Tactile and Surface Structure measurement, Barkhausen Noise Checking and Laser Scanning.
GRSL Composite and Non-Contact Index and Profile Analyzer for in-process measurement
Solutions / Smart Loop

From the Idea to the Perfect Driveline System.

Latest Gear Design and Transmission Simulation Software from KISSsoft and Gleason GEMS (Gleason Engineering and Manufacturing System) work closely together to develop the perfect solution for specific transmission challenges, from the idea to the final product.
Solutions / Smart Gear Factory

Process Optimization

Production Streamlining

Tool Communication

Systems availability

gProcess

gProduction

gTools

gUptime
Chamfering and Deburring

- Chamfering/deburring can be necessary to prevent:
  - Broken-off hardened burrs which can damage the complete gearbox.
  - Carburized sharp edges can break off easily.
  - Injuries when gears are handled manually.
  - Clamping issues.
  - Tool life reductions in subsequent hard finishing processes.
Gear Chamfering on Genesis Hobbing Machines

Chamfer Rolling 210HiC
Chamfer Contour Milling 160HCD, 400HCD
Chamfer Hobbing 160HCD
Chamfer Hobbing

Hobbing with Parallel Chamfering of Smaller Gears
Grinding and Honing are partially competing processes.
Each process has advantages and disadvantages.
Choosing the right process requires the consideration of many criteria:
- Goal of hard finishing
- Target quality
- Surface requirements
- Amount of stock to be removed
- Process chain and application
- General shape of the part
- Target cost
Power Honing

Gleason 150SPH
Spheric Power Honing Machine
Threaded Wheel Grinding
One major challenge

Requirement for desired twist.
Grinding – What is Twist

- Twist is a geometric phenomena in profile & threaded wheel grinding when grinding flank modifications.
- Twist is not dependent on the machine tool itself.
- The higher the
  - module m
  - helix angle \( \beta \)
  - face width of the gear \( b \)
  - amount of flank modification
    eg. lead crowning \( c_\beta \)
  the higher the resulting twist!
- Twist has a negative impact on the noise behavior of mating gears!
Grinding - Twist Modification Compensation

left Flank

right Flank

Profile Crowing 2 µm
Lead Crowing 3 µm

neg. Twist → pos. twist
Grinding - Twist Modification Compensation

Profile Crowing: 2 µm
Lead Crowing: 3 µm

neg. Twist  pos. twist
Grinding - Twist Modification Compensation

- Lead crowning $c\beta$
- Generated tooth topography
- Generating contact line
Grinding - Twist Modification Compensation

<table>
<thead>
<tr>
<th>$f_{H\alpha}$</th>
<th>left flank (LF)</th>
<th>right flank (RF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>top</td>
<td>-15µm</td>
<td>+9µm</td>
</tr>
<tr>
<td>middle</td>
<td>-2µm</td>
<td>-2µm</td>
</tr>
<tr>
<td>bottom</td>
<td>+8µm</td>
<td>-16µm</td>
</tr>
</tbody>
</table>

amount of twist $s_{\alpha}$

$s_{\alpha}$  | -23µm | -25µm |
Grinding - Twist Modification Compensation

natural amount of twist
\[ s_\alpha = -21 \, \mu m \]

twist compensated
\[ s_\alpha = -1 \, \mu m \]
Different amount of twist modification for left & right flank possible in double flank grinding.

Twist modification for different amount of flank crowning on left and right flank possible in double flank grinding. (see example on the right)

Unique feature on Gleason machines
Already integrated in KISSsoft design software
Gear Inspection Systems and Hard Finishing Machines work closely together comparing theoretical design and finished workpiece. Correction data is transferred via scanned code or directly - simple and fast.
Closed Loop for Inspection Results

Machine

Ground part

Feedback of Measured Results

Inspection Sheet

Gear Inspection
Process Simulation

Gleason provides the most advanced Power Skiving Process Application Engineering Tool.

Before starting to design a tool for a specific workpiece we simulate the feasibility of production with real worklife variables for both

Soft and Hard Power Skiving
How Power Skiving works

- Axial feed
- Radial Infeed
- Cross axis angle $\xi$
- Cutter revolution
- Work-piece revolution
How Power Skiving works
Potential Industries for Power Skiving Applications

### ATM
- **Internal Ring Gears**
- **Sun Gears**
- **Double Planets**
- **Dogsplines**

### DCT/MT
- **Input shaft:** gear II and spline
- **Output shaft:** splines

### DHT/Electro
- **Rotor shaft**
- **Internal Ring Gear**

### Industrial, Robotic
- **Ring gear bodies**

### Motorbike
- **Shift Gears**

### Aircraft
- **Flap actuators**

### Construction, Mining
- **Large gears**
Technology and Simulation Software

Analysis of the Power Skiving process needs to involve
- Cutter geometry
- Process parameters
- Conditions of chip formation
- Avoiding collisions
- The resulting quality

All influencing parameters need to be considered when carrying out a process analysis for Power Skiving.
Technology and Simulation Software – Chip Building
Technology and Simulation Software – Chip form

![Graph showing chip form with dimensions and parameters]

- Zahntiefe: 0.76
- Vorschub: 12
- Verdrehung C: -0.638
- Achsabstand gerechnet: -22.30
- Zustellung: 0.76
- Achskreuzwinkel: 20
Technology and Simulation Software – Collision Analysis
Technology and Simulation Software - Interference Check

Will be integrated in KISSsoft design software Release 2019

Distance Z

\[ \xi \]
Technology and Simulation Software

![Graph showing lead deviation with various parameters listed on the right side.](image)
Technology and Simulation Software

Power Skiving Chip Simulation
Technology and Simulation Software – Cutter Design
Power Skiving Tool types

Disc Type Cutter

Bell type cutter

Shank type cutter
Power Skiving with integrated roll-chamfer

100PS Power Skiving Machine with Integrated Chamfering Option
Application example – DCT Input Shaft

Gear II, with integrated chamfering

Spline
Thank you for your attention

connect with us at www.gleason.com