With the development of new cutting tool technology, chamfering with hobs has found new life; chamfer hobbing is now the process of choice for chamfering and deburring automotive-size gears in medium and high volumes.

By GOTTFRIED KLEIN

In the last few years, chamfering and deburring have gained new respect and risen to a level of importance equal to that of other processes. Manufacturers of Electrical Vehicle (EV) drive systems, where noise behavior is of paramount importance and hard finishing a must, are keenly aware of how an improperly chamfered and deburred gear can lead to unacceptable noise and raise the risk of premature transmission wear and even failure. In fact, for almost every manufacturer of automotive and truck-size gears, it’s no longer a question of should you chamfer and deburr, but how to do it most cost effectively?

CHAMFERING CHOICES

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 can now use the optimum chamfering technology for their particular application either simultaneously with, or sequentially to, the hobbing operation — all fully automated and performed onboard the same machine.

These technologies include:

- **Chamfer rolling**: A ‘tried and true’ process ideal for planetary pinions with cycle times of less than 10 seconds 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.

- **New chamfer hobbing**: Now the process of choice for medium and high volume production and dry cutting, offering the highest tool life with lowest tool cost per workpiece.

CHAMFERING WITH HOBS, ONLY BETTER

While chamfering with hobs has been known for decades, the process is confined to spur gears and has limits in executing current customer chamfer specs. With the development of the chamfer hobbing process, chamfer cutting technology has made an important leap forward. Chamfer hobbing is now the ideal chamfering process for medium- and high-volume production of automotive-size gears with the ability to economically produce all the required chamfer tolerances that exist today and those expected well into the future.

Unlike a conventional hob, the new chamfer hob is designed with asymmetric teeth: an active flank for cutting the desired chamfer form, and a passive flank designed to avoid contact with the opposite flank. As a result, the chamfer hobbing process employs one

![Figure 1: Chamfer hob at work: active hob flank on the left designed to cut the chamfer; passive hob flank on the right designed to avoid the opposite gear flank.](image1)

![Figure 2: Simulation software speeds development of an optimized chamfer hob. Here, a simulation of a root cutting trace is shown.](image2)
dedicated chamfer hob for each tooth flank (Figure 1).

The chamfers on the left and right flank are cut in a generative mode using these separate, dedicated chamfer hobs. This gives users the flexibility to meet the widest range of gear performance objectives and accommodate applications with different geometries on the gear faces. Each chamfer hob can be designed to produce comma or parallel-chamfer forms, with or without root chamfering. Similar chamfer angles like those commonly produced in the chamfer rolling process can be achieved (e.g. 15-30 degree on obtuse edge, 25-45 degree on acute edge).

Note that, in most other respects, these tools closely resemble the typical gear hob, with similar diameters and the same High Speed Steel (G30 and G50) materials with AlCroNite® Pro Coating.

OPTIMIZED DESIGN, GREATER FLEXIBILITY

The hob profile is specifically designed to generate a particular chamfer form. The design process, and manufacturing the chamfer hob downstream, is made easier, faster, and more foolproof through use of special Gleason Simulation Software. Gleason software is used to simulate the required chamfer and to avoid all potential collisions of the tools with the counter flank and with interfering contours above and below the actual gearing. Additionally, as the chamfer is cut with separate hobs for left and right edge, it is critical to avoid any material accumulation or steps in the root when chamfering the root. The simulation (Figure 2) and the ability to both alter the chamfer hob macro-geometry and immediately simulate the outcome help to optimize the root area.

By cutting into the gap, burrs can be avoided on the face side of the gears. With the chamfer angles comparable to those produced by the chamfer rolling process, there are no measurable burrs on the flank that require removal downstream.

This software is a powerful tool that enables the designer to quickly develop, through simulation, the optimum cutting tool profile needed to produce the defined chamfer angle and form. Once manufactured, the chamfer hob is ready, from day one, to achieve the desired results without the time consuming and expensive trial and error and test cutting that has characterized chamfering with hobs in the past.

In application, the cutting tool is used by the new Gleason Genesis® 160HCD Hobbing Machine, which combines a vertical hobbing platform with an integrated chamfering/deburring station to perform the new chamfer hobbing process in parallel to hobbing. While the design of the chamfer hob pre-determines the chamfer angle and chamfer form, the integrated chamfer-hobbing unit offers enormous flexibility. Its axis configuration is similar to the main hobbing machine, all NC-controlled by the shared Siemens 840D sl control. As a result, program adjustments can be made automatically to accommodate corrections in variables such as gear size and helix angle in advance of the chamfer hobbing operation. Importantly, radial tool position can be adjusted for changes in root chamfer size and overlapping of left and right chamfer angle.

Additional flexibility is offered with an optional chamfer hob head that can accept up to four chamfer hobs (See Figure 3). While two chamfer hobs are sufficient for workpieces with parallel gear faces, up to four chamfer hobs on a single spindle can produce parts with asymmetric gear faces such as inclined gear faces, special
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gears or even two gears on a shaft — all of which could be chamfered in a single setup.

With the addition of a tailstock, all types of shaft-type parts can be accommodated, including shafts common to eDrive transmissions. These shafts, where the root diameter of the chamfered gear and the shaft diameter are often in very close proximity, are inherently more difficult to chamfer and deburr due to the clearance requirement (see Figure 4).

The use of simulation makes it possible to find and apply a chamfer-hobbing solution that can produce the desired chamfer and eliminate the potential for a burr between chamfer and flank that could affect tool life in the hard-finishing operation downstream.

Regardless of the parameters, setting up the machine, whether for a typical application of two chamfer hobs, or for more specialized four-hob applications, is made easy for the operator via Gleason gTools online connection to a database, or with a USB flash drive that comes with the cutting tools and contains all the setting parameters that would typically need to be input manually. The operator can upload the data much more quickly and without the potential for operator error.

DRIVING DOWN TOOL COST PER PIECE

The chamfer hobbing process also is characterized by incredibly high tool life. It’s not unusual for a chamfer hob to produce more than 30,000 parts before requiring resharpening, thus greatly minimizing the time needed for changeover. The savings in non-productive time translates into a tool cost per workpiece on average of just 1 cent. This is due to the ability of the chamfer-hob unit to incrementally shift the chamfer hob’s position along its tangential axis to maximize the cutting area used on the hob flank.

When resharpening is required, reconditioning of chamfer hobs is similar to that of standard hobs and can be performed by using existing hob reconditioning/resharpening capabilities.

ABOUT THE AUTHOR

Gottfried Klein is director of Product Management Hobbing, Chamfering, and Shaving with the Gleason Corporation. To learn more about chamfer hobbing and the other chamfer/deburr options now available, go to: www.gleason.com.