Peel grinder offers advantages that go beyond hard turning

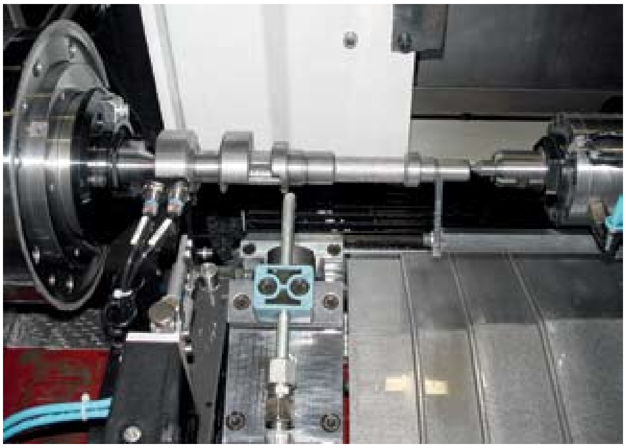
Hard turning has become a very popular process for producing shaft-type automotive drive-train components largely because of its inherent flexibility. A turning tool doesn't care what diameter it's producing and can easily produce multiple features on the same part, or different features on a different part, with little or no changeover downtime.

Of course, many hard-turned components may still need to be finished on a grinder to achieve the required tolerances. As long as the production runs are large enough to justify a dedicated grinding operation, standard plunge grinding solutions handle this requirement adequately. What's been missing from the equation until recently, however, is a grinding technology that matches the flexibility of the hard-turning process at a cost that's competitive with the traditional dedicated solutions.

That technology is known as peel grinding. It was pioneered in Europe by Cinetic Landis Grinding Corp's sister company, Cinetic Giustina Grinding of Torino, Italy, and is available in the Cinetic Landis Evolution series of machines.

Peel grinding combines the durability and efficiency of CBN wheels, with the process advantages of high-speed grinding, to create a highly flexible system that perfectly complements hard turning in the production of shaft-type parts, gears, tripods, and other powertrain components. The wheel is very narrow, typically 5mm or smaller, and operates at speeds up to 250m/sec. along with part rotational speeds of up to 7,500rpm. This combination offers a number of unique advantages for the process.

The narrow wheel addresses the workpiece in much the same way as a turning insert. It easily handles multiple diameters and can produce grooves, thrust faces, and other common features found on powertrain components. Changing parts is largely a matter of changing CNC programs, since like a turning insert, the wheel really doesn't care what diameter it's producing.



Peel grinding combines the durability and efficiency of CBN wheels, with the process advantages of high-speed grinding.

Because it operates at very high speeds, both cutting forces and heat input into the workpiece are minimized, making the process ideal for hard parts. The low forces also eliminate the need for any mechanical workpiece clamps. Center pressure is sufficient to drive the part, which further enhances the peel grinder's flexibility.

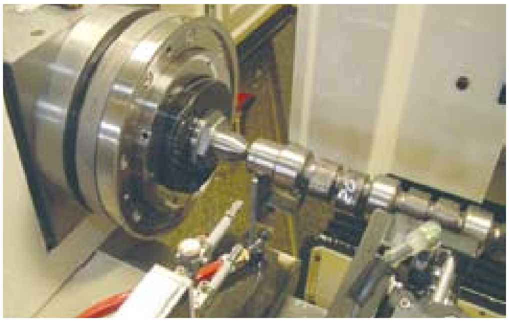
Because of the exceptionally high speeds applied in peel grinding, chip size – which is directly proportional to work speed and wheel speed – is significantly reduced, thereby decreasing the stress that is induced into the part, decreasing surface roughness and eliminating the need for secondary polishing operations.

Peel grinders use either vitrified or plated CBN wheels, which offer exceptionally long life when used in high-speed applications. Wheel life of 100,000 parts and more is routinely achieved, even in applications on difficult parts. Extended wheel life also minimizes the need for dressing and can eliminate the need for in-process gaging in many applications.

The system design

Designing a grinding system to take full advantage of these characteristics in a production environment is a major challenge. Above all, the system has to be extremely rigid and thermally stable. In the Evolution machines, this is accomplished by using a natural granite bed, since this material combines the necessary rigidity with the best resistance to thermal deformation available in any currently practical bed material.

A motorized wheelhead spindle equipped with hybrid steel/ceramic bearings is used to achieve the required wheel speeds up to 15,000rpm while maintaining system stiffness. It is automatically balanced and equipped with advanced acoustic sensors to monitor both the grinding and dressing operations.



Application on the Cinetic Landis Evolution series of machines

The dresser is mounted on the workhead spindle to maximize stiffness and facilitate the minimum practical removal of CBN from the wheel during dressing. The minimum dress increment is 0.001mm. It is interesting to note that because of the characteristics of the high-speed process, and the extreme wear resistance of CBN, dressing is the major cause of wheel wear on Evolution-series grinders.

Obviously, there are many other special features of the Evolution grinders required to make sustained high-speed operation possible. For example, a special wheel cleaning system is incorporated in the wheel hood that uses filtered coolant to remove grinding debris efficiently without the need for a high-pressure pump. Other system components are quite familiar, though, including the ballscrew wheelhead and tailstock drives and the precision optical scales used to track wheelhead movements.

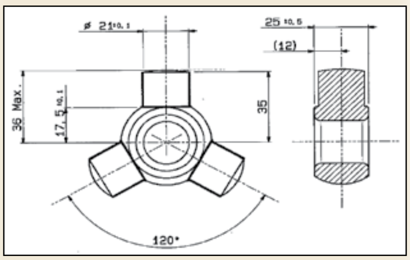


Figure 1 – Evolution Tripod

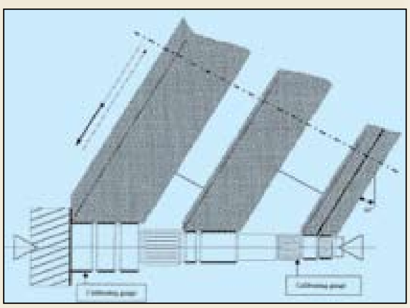


Figure 2 – Evolution transmission shaft conventional application

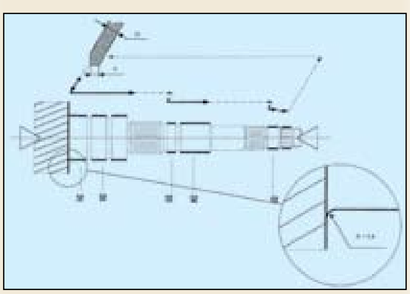


Figure 3 – Evolution peel grind application

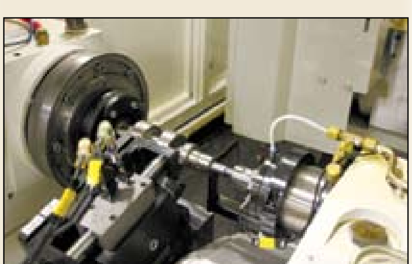


Figure 4 – Evolution balance shaft

Production floor proof

But the proof of concept is best found on the production floor where the Evolution grinder has demonstrated both its productivity and flexibility. Evolution grinders are being used today to produce a variety of powertrain components in Europe, Asia, and North America.

The automotive tripod shown in Figure 1 is a good example. It is ground from an as-forged and case-hardened 16 MnCrS5 steel blank in a two-step process. A plated CBN wheel (in position one) running at 180m/sec is used to rough the diameter and finish the face and two grooves. Stock removal is about 1mm.

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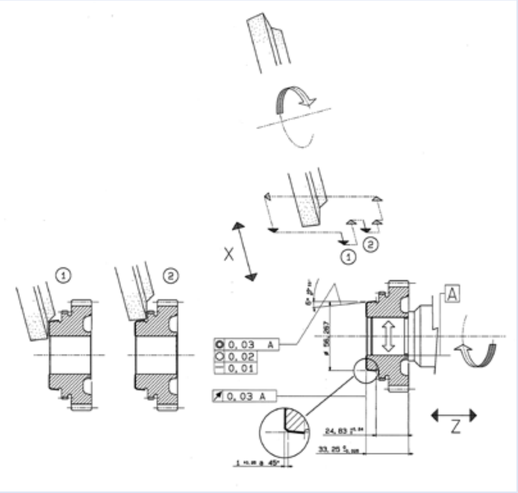
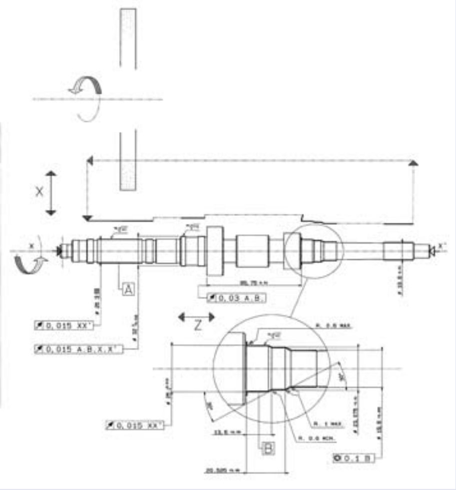
Other peel grinding applications using Landis Evolution CBN high-speed grinders

Pinion

Hardened and tempered (163/201 HB) pinion of 27 MC 5 JV steel plunge ground to produce the cone angle and two thrust faces.

Wheel speed: 120m/sec.
Wheel diameter: 400mm
Wheel material: CBN in a ceramic binder
Cycle time: 29sec
Roughness: R = 1.1
Circularity: 0.003mm.
Cone runout: 0.0035mm.
CAM on the position of the absolute diameter: 2.40





Transmission primary shaft

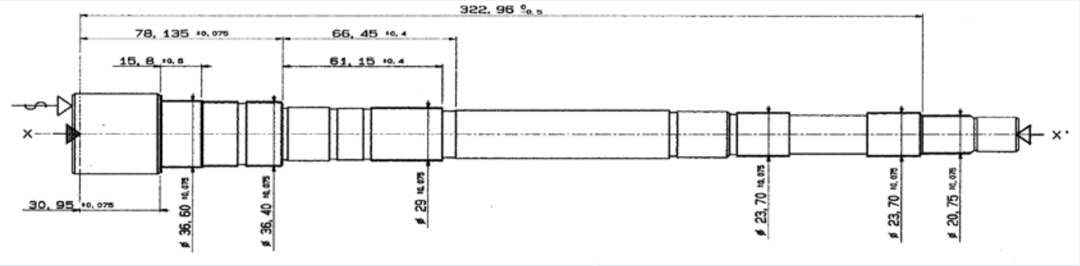
Carbonitrided (680/900HV) shaft of 27CD4 steel peel ground to produce nine diameters and two thrust faces.

Wheel speed: 120m/sec.
Wheel diameter: 400mm
Wheel material: CBN in a ceramic binder
Cycle time: 1min 20sec
Roughness: R = 1.6
Circularity: 0.0023 mm.
Runout: 0.008 mm.
CAM on the more accurate diameter: (Ø25) = 1.69

Transmission secondary (driven) shaft

Carbonitrided (680/900HV) shaft of 27CD4 steel peel ground to produce seven diameters and three thrust faces.

Wheel speed: 120m/sec.
Wheel diameter: 400mm
Wheel material: CBN in a ceramic binder
Cycle time: 43sec
Roughness: R = 1.8
Circularity: 0.003mm.
Runout: 0.004mm.
CAM on the more accurate diameter: (Ø28.4) = 1.61



The same vitrified CBN wheel (in position two) on the same spindle is then used to finish grind the diameter to a roughness of R2.2 at 120m/sec. Total cycle time for all three arms of the tripod is 31sec. Tool life averages 150,000 plunges per wheel, which translates to 50,000 parts. More than 20 Evolution machines have been supplied to the Asian manufacturer that produces these tripods for a variety of automakers.

An automotive transmission input shaft is another good example. The conventional grinding process shown in Figure 2 used three wheels to produce the bearing diameters in a 54sec cycle. But since the diameters are different, the wheels wore at different rates. The result was a 6 percent scrap rate. The process also required a separate grinder for each of the two shafts produced.

Replacing both machines with a single Evolution peel grinder reduced the cycle time to 42sec and the scrap rate to less than one percent (Figure 3). Changing from one part to the other is accomplished in the CNC, which automatically recognizes which part is presented for machining.

Five diameters and four thrust faces are produced in a 64sec cycle on the balance shaft shown in Figure 4, using an Evolution grinder. Another member of the same part family has four diameters and three thrust faces completely ground in 54sec on the same machine. Again, part-to-part change-over is accomplished in the CNC, with downtime determined essentially by the time required to re-position the tailstock.

Peel grinding offers significant advantages, but like all processes, it also has limitations. For best results, metal-removal requirements should be kept as small as practical and should be as uniform as possible from part to part. The process is capable of significant metal removal, of course, but using it to remove large amounts of metal tends to negate the productivity and tool life advantages that are its main benefits.

Best results are achieved when peel grinding is integrated into a production system that delivers near-net-shape parts to the grinder. This makes it a natural final step in a production process based on hard turning, where the peel grinder can provide both high-precision and super-finishing capabilities.

Making this work requires recognizing that peel grinding is not at all like the conventional grinding processes with which process designers are familiar. It needs to be approached carefully to take full advantage of its unique capabilities.

In particular, the common practice of "letting the grinder take care of process variations" in upstream operations should be avoided. These operations need to be monitored and controlled as carefully as the grinding operation to achieve maximum productivity.

When that is done, however, the payoff can be significant. Peel grinding combines productivity and flexibility with traditional grinding precision in a package uniquely suited to meeting today's manufacturing challenges. Teamed with hard turning, or as a stand-alone process, it is destined to become the process of choice for a steadily growing number of powertrain components. **Cinetic Landis Grinding Corp., www.rsleads.com/706tp-150**