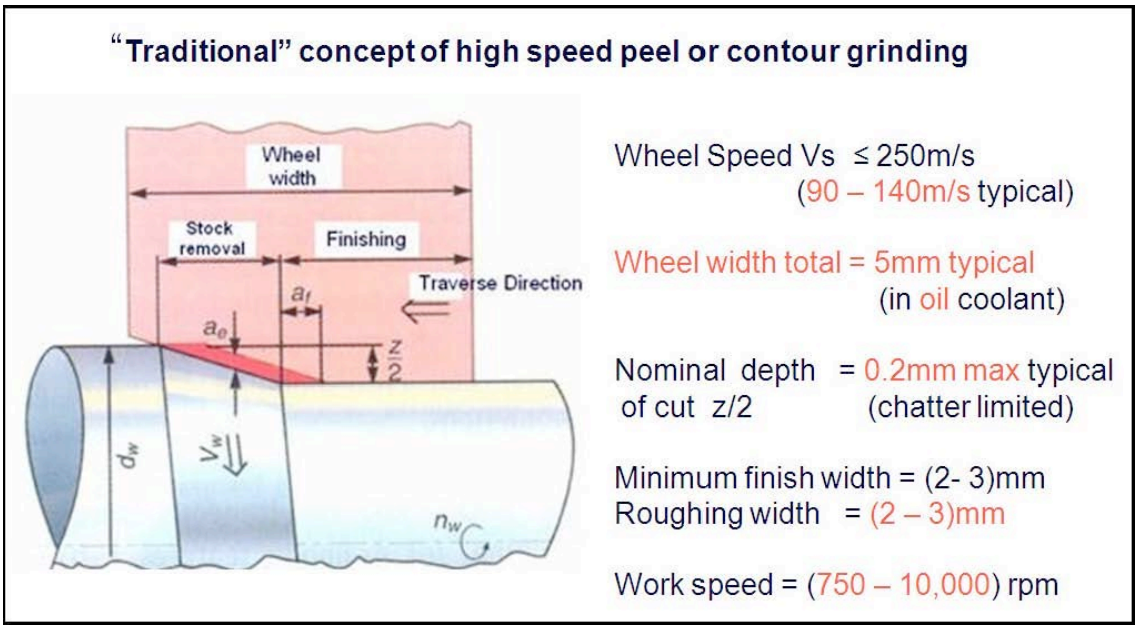
Peel Grinding

Although more widely accepted in Europe, US manufacturers are now starting to show an interest in peel grinding in two primary areas. 1) As an alternative to conventional formed wheel plunge grinding to reduce set-up time by eliminating the need for grinding wheel and dresser roll changes between parts. This allows for shorter lot runs and reduced "work-in-process" inventory. 2) As an alternative to hard turning for improved statistical control, lower tooling "cost-per-piece", and as a better way to handle surface interruptions such as keyways and slots that can be difficult to address with single point turning tools.

High speed peel grinder from Weldon Solutions



The trailing 2 – 3 mm of the wheel face helps generate the required finish and maintains the final part size. Generally there is very little wear on the O.D. of the wheel in this region, and with a traverse rate of typically >100mm/min but work speeds of 1000rpm or more, the overlap factor for generating finish can be well in excess of 20. In general, the finish is extremely stable until wear reduces the length of the finishing section to an overlap of just 2 or 3 at which point finish, geometry and size becomes erratic.

Strategies for Peel Grinding in Water Based Coolants:

Coolant selection and application is critical to peel grinding. When peel grinding was introduced, wheel life appears to have been the over-riding factor. To maximize life oil was the coolant of choice. Oil provides significant benefits in terms of lubrication properties and for CBN in particular reduced grain wear. However, environmental issues have created strong resistance in the USA to the introduction of processes requiring oil coolant and have pushed machine tools builders to explore the potential for peel grinding in water based coolant.

A second benefit of converting to water is thermal effects. Water based coolant appears to reduce burn. This was interpreted by assuming the reduction in frictional benefits of oil at these removal rates being marginal and the more critical factor being to get the heat out of the grind zone. Also, it was found that the temperature fluctuations using oil were much greater such that on several occasions it was only possible to hold the required micron size tolerances in water even with in-process jump on gages. An additional benefit of water based coolant is its lack of flammability. The peel process can generate "fire" with the majority of the heat going into the chips.

There are several machine features required for success with peel grinding:

a) **High static stiffness is required for both size and process control. Any movement or vibration has been found to cause chatter and burn. The process is sensitive to chatter because of the high work speeds involved. Coupled with general high machine stiffness is the related need for extremely rigid work-holding capability. The work piece is generally held between centers using friction or face drives for ease of part change over.**

b) **Spindle power is in the range of 25HP sustainable at 25,000 SFPM (127m/s). For a 20" wheel. This corresponds to a peak power at 4800 RPM. At these speeds dynamic wheel balancing is critical.**

c) **Electric dresser motor capable of 12,000rpm to give a minimum of +0.6 dress crush ratio (depending on diamond roll size).**

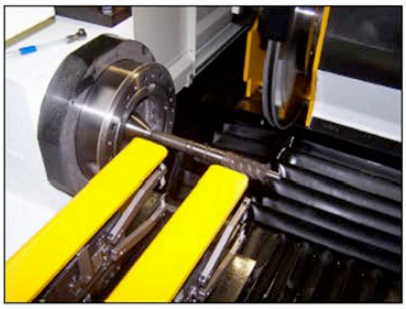
d) **High pressure coolant for wheel scrubbing and cleaning (approximately 1000 psi) is especially critical for grinding of exotic and soft materials).**

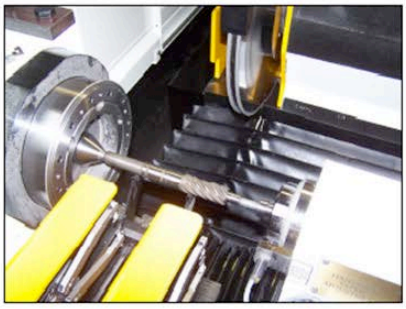
e) **Machine coolant system requires a high velocity main coolant nozzle with design specifics based on application e.g. shoe, slot, multi-nozzle, etc.**

f) **High thermal stability for both size and general process control. Water based coolant greatly aids process stability combined with efficient bed and motor wash. However, it is often still necessary to use in-process gaging.**

g) **Acoustic emission based sensing system for wheel contact both in dressing and grinding. The sensor is mounted in the wheel spindle separate from the balancer for maximum sensitivity.**

Grinding of steel pinion shafts (Weldon 2006)

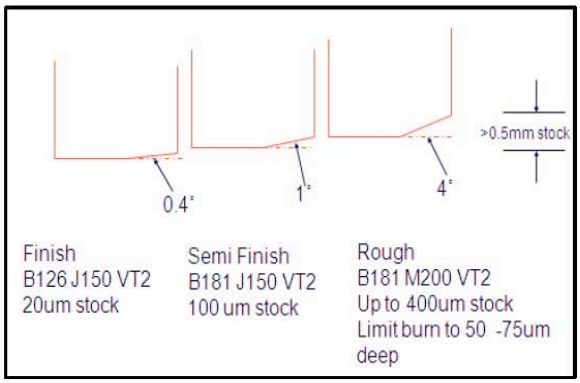


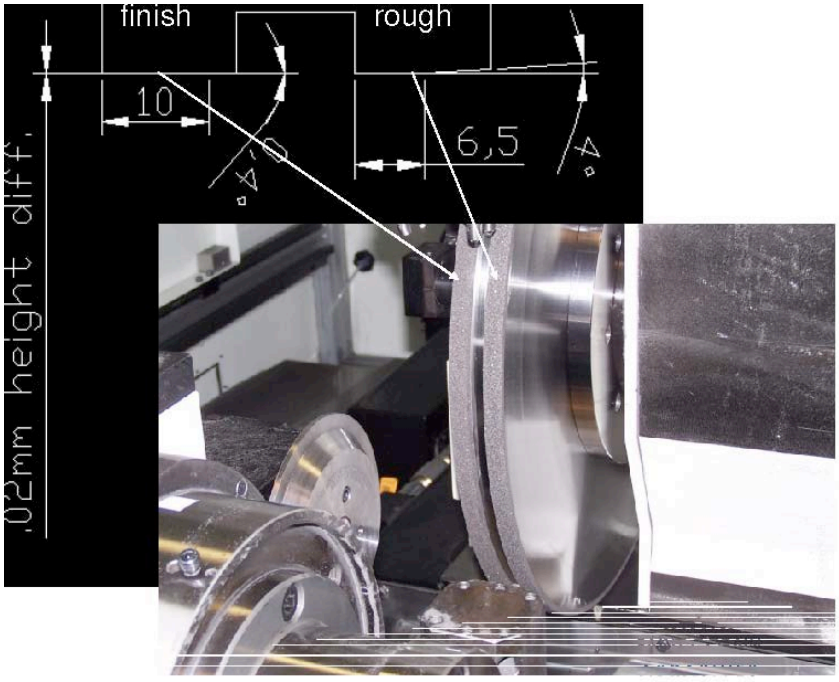


Configuration:	Straight wheel slide CBN OD wheels Workhead spindle dresser ring Friction drive Dual post-process gaging 2-axis gantry loader Loop conveyor	
Process:	Fully automatic high-speed peel grind multiple diameters, shoulders, and blend angle.	
Attributes:	OD size Surface finish	+/- .0045 mm (2.0 Cpk) .4 Ra (max)
Notable:	Three-machine cell, dual wheel set-up, peel grinding four diameters and two shoulders (left and right hand side) in a floor-to-floor cycle time less than 40 seconds.	

Wheel life can be further improved by having separate roughing and finishing wheel sections ganged together. The roughing section is of a coarser grit size and removes the bulk of the material while the finishing wheel removes typically 20um and generates the required finish. For this configuration the life of the wheel is limited by the maximum wheel grade in the roughing section to not create thermal damage. This can be taken one step further using 3 wheel sections. The 1st section is a roughing section which may induce burn to a depth of 50 – 75um, which removed by the 2nd semi-finishing section. Finally the 3rd section generates the finish

Rough /finish Grinding of hardened Tool Steel Shafts (Weldon 2008)





Summary

The need for flexibility and fast changeover coupled with ever tightening print specifications, statistical requirements, and cost containment pressures requires utilization of advanced machining technology. High speed grinders incorporating peel grinding technology, while expensive in their own right, can actually decrease capital investment by elimination of multiple operations including grinding, turning and polishing. Additionally, through the use of CBN abrasives, total cost per piece has become a fraction of that of conventional hard turning, grinding and polishing methods. The reduction of grinding force inherent to high speed peel grinding can often eliminate the need for conventional work drivers (most components can be driven by center pressure, or a face driver) allowing the machine to grind complex shafts in one setup further eliminating additional grinding machines and/or operations. Changeover from part to part can be accomplished in seconds.