



REACHING NEW HEIGHTS
WITH SUPER PRECISION TURNING



The background of the entire page is a high-contrast, black and white photograph of metal shavings. The shavings are thin, curved, and tangled, creating a complex, organic pattern. They are illuminated from the side, highlighting their metallic texture and the sharp edges of the curls. The lighting creates a sense of depth and movement, with some shavings in sharp focus while others are blurred in the foreground and background.

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THE NEW CHALLENGE IN PRECISION MACHINING

Today, manufacturers face tremendous pressure to adapt to new trends while keeping costs low and optimizing productivity – but it is not easy. With customer demand for increased customization and shorter lead times, not to mention rising costs and pressures to improve efficiencies, the business of making components gets more complex every day.

In today's advanced manufacturing space, there is no room for error. Parts must meet the engineering specs, with no variance – period.

To achieve optimal efficiency and parts uniformity, industry leaders use precise hard turning centers to produce complex workpieces with painstakingly correct detail and form tolerances.



TRENDS DRIVING PRECISION TURNING

Due to increasingly complex requirements, traditional turning and grinding equipment may not be enough to meet today's requirements. There are a number of factors driving the next generation of precision turning.



New lighter, stronger manufacturing materials require tools that can machine the new materials at the highest possible levels of productivity.



New efficient product designs require extremely complex and tight-tolerance components for accuracy, safety, and optimal performance.



High cost of grinding.



New environmental rules regarding the disposal of machine cuttings.

TODAY'S PRECISION TURNING REQUIREMENTS CHALLENGE

Ninety-five percent of the general precision turning market is removing metal from finishing operations while holding tolerances of plus or minus 12 micron in production. But many shops struggle to meet the market's new demands for tighter tolerances, so more parts, including semi-finish work are sent to the grinding machine to finish.

Yes, hard turning has provided the solution for semi-finish and some finish work. However, is the average CNC lathe capable of precision hard turning to complete the part in one set up for today's tighter tolerances?

The answer is no. Here's why.

1. Dimensional tolerances including OD and ID are becoming tighter. While dimensional tolerances are still critical, form tolerance has become more prevalent in today's machining applications.
2. Machine tools that are more accurate are required to maintain tighter form tolerance in roundness, cylindricity, true profile and sphericity.
3. At the same time, the industry is also demanding finer surface finishes.

In many cases, a general precision CNC lathe and a grinding machine could get the job done together. However, that means you need two machines and two operators. Super precision hard turning is the more efficient, economical alternative.



PRECISION HARD TURNING COMES OF AGE

Super precision hard turning's attractiveness lies in its potential for eliminating the need for grinding operation during the finish.

Hard turning is defined as the process of single point cutting of part pieces that have hardness values over 45 Rc. However, hard turned part pieces will typically be found to lie within the range of 58-68 Rc. The precision hard turning process is similar to conventional soft turning. This means that the introduction of this new process into a normal factory environment can happen with relatively small operational changes.

The typical materials routinely used in hard turning fall into the following broad category descriptions:

- **Steel alloys**
- **Bearing steels**
- **Hot and cold work tool steels**
- **High speed steels**
- **Die steels**
- **Case hardened steels**
- **Waspoly, Stellite and other aerospace alloys**
- **Nitrited irons and hard chrome coatings**
- **Heat treatable powdered metallurgy**



THE NEXT GENERATION: SUPER PRECISION TURNING

The turning industry is rapidly moving toward super precision hard turning that can support the tight tolerances required today. Super precise turning centers incorporate a combination of best practice design and hardware / software integrated into a production machine tool. These machines are able to produce meticulous results with a minimum of human intervention – repeatedly.

Key users for super precision turning include:

- Gauging
- Bearing
- Tooling
- Mold & Die
- Power Industries
- Grinding Houses

GRINDING PROCESS

OPERATION	TIME
SETUP OD & FACE	15 MIN.
GRIND OD & FACE	5 MIN.
MIN. SETUP ID	30 MIN.
GRIND ID	10 MIN.
SETUP TAPER	40 MIN.
GRIND TAPER	4 MIN.
TOTAL SETUP TIME	85 MIN.
TOTAL RUN TIME	19 MIN.

HARD TURN PROCESS

OPERATION	TIME
SETUP LATHE - 3 TOOLS	25 MIN.
HARD TURN	—
TURN & FACE	88 SEC.
BORE ID	42 SEC.
TURN ANGLE	65 SEC.
TOTAL SETUP TIME	25 MIN.
TOTAL RUN TIME	3.3 MIN.

In some cases, a super precision turning solution allows you to eliminate grinding. It enables you to complete a part on one machine, using one operator, and running at higher throughput, resulting in a lower cost per part.

SETUP TIME REDUCTION 340%
CYCLE TIME REDUCTION 575%

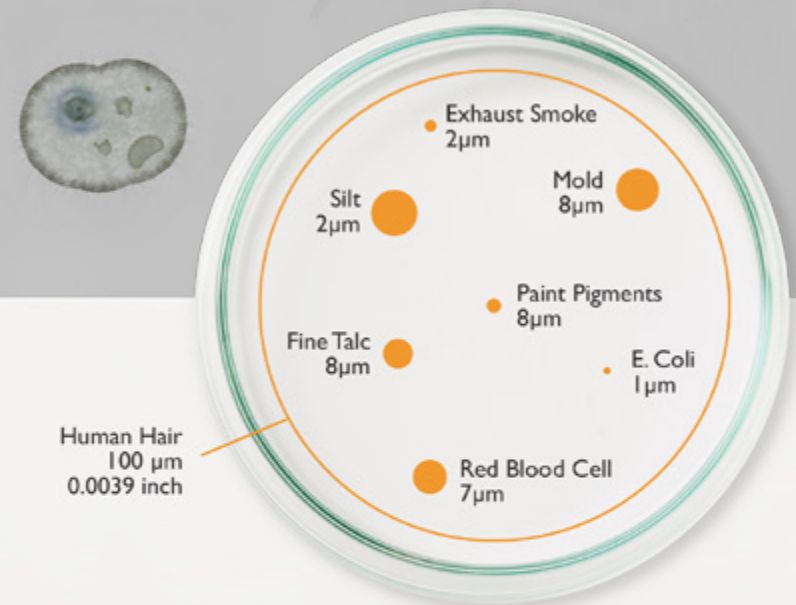
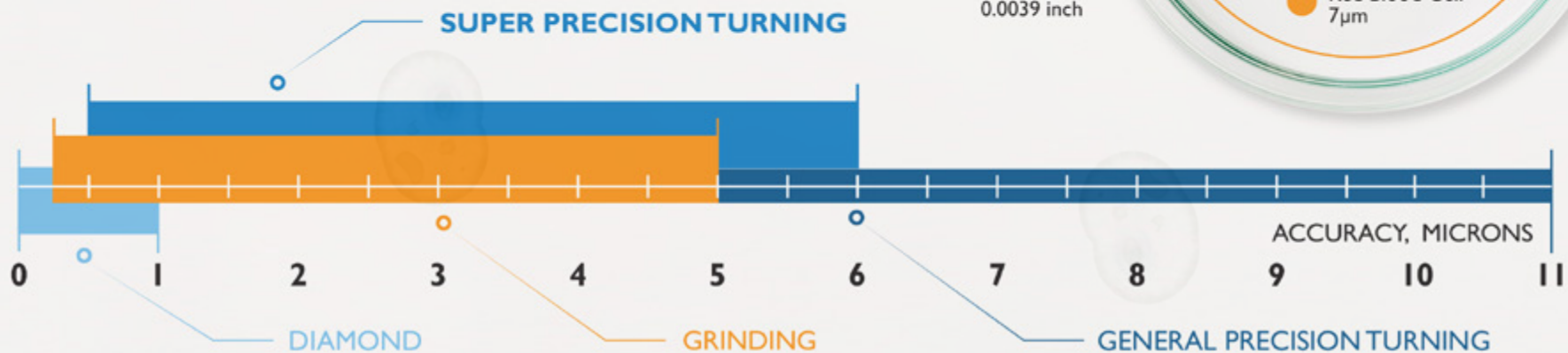
SIZE MATTERS – HOW PRECISE IS SUPER PRECISE?

Super precision turning ranges from .5 microns to 6 microns, overlapping the capabilities of diamond turning, grinding, and general precision turning. While many machine tools offer standard resolutions of .0001 inches, the new industry standards require machinery that incorporates .000010 inches programmable resolution capabilities, beyond the capabilities of many manufacturers. But modern super-precision turning centers can provide accuracy in the lower range of diamond-turning machines (cylindricity of less than 1–2 μm), turning out pieces within the 2-micron range.

With super precision turning centers, manufacturers can achieve outstanding performances and meet exacting standards up to .5 micron. How small is that? With bacteria cells typically sized at 1 micron, that makes .5 micron only half the width of a single cell.

We're talking about parts with accuracy at the microscopic level.

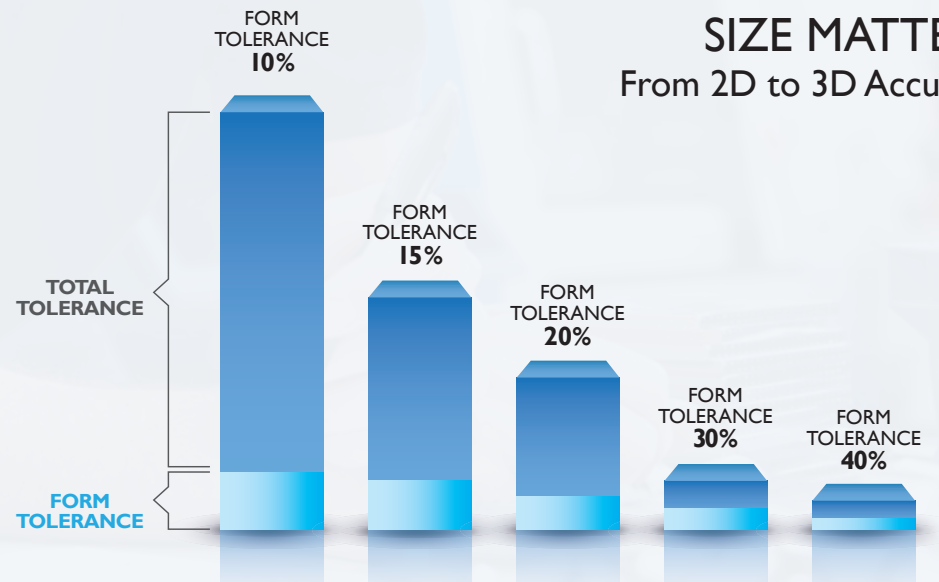
New technology has allowed turning centers to encroach upon grinding tolerances





FORM TOLERANCES ALSO MATTER

Along with precise details, workpieces need to meet form tolerance standards and the desired geometric form, including roundness and cylindricity. Good news – super precise turning centers shine here as well, producing workpieces with exact surface finish and form tolerances from 2D to 3D accuracy.



STABILITY - IT'S ALL ABOUT THE BASE

The remarkable accuracy produced by super precise turning centers can only be accomplished with an extremely stable base. Super precise turning centers have to have extraordinary stiffness and unmatched stability to offset the high-pressure force of the machining process. This stability inhibits thermal deformation and twisting, allowing for super precise cutting performance and existing part accuracies.



Super precise turning centers are delivered using “air-ride”, a specialized truck that uses an air ride suspension system. By replacing standard steel spring suspension systems with compressed air, an air ride offers higher shock absorbancy, and provides a smoother, more stable transport. to maintain the machines accuracy.

THE NEW NORMAL IS SUPER PRECISE

The current demands of tight-tolerance parts in industries such as medical, aerospace, and defense, are pushing the extreme limits of machine tool accuracies and repeatabilities. The new normal for these applications is super precision turning. Let's compare accuracies with super precision turning versus general hard turning.

ACCURACIES	SUPER PRECISION HARD TURNING	GENERAL HARD TURNING
Dimensional accuracy on diameter	+/- 2.5 micron on diameter	+/- 10 micron on diameter
Dimensional accuracy on straight turns	.15 micron finish	.30 micron finish
Dimension accuracy on arcs and tapers	.2 micron finish	.4 micron finish
Dimensional accuracy on roundness	1 micron part roundness	5 micron part roundness
Continuous machine accuracy	3 micron	15 micron

BENEFITS OF SUPER PRECISION TURNING

There are significant benefits with super precision turning including reducing investment in specialized grinding equipment, and the ability to perform multiple CNC machining operations with one setup, thus improving throughput and reducing cost-per-part. Here are eight benefits to consider.

1. Improved accuracies and form tolerances.
2. Improved surface finishes and statistical process control (CPKs).
3. Set-up and process time are reduced by more than 70% when compared to grinding, including eliminating downtime for wheel dressing.
4. Three to five times increased fine micro finishes and metal removal rates.
5. Off the shelf cutting inserts can be used instead of expensive form grinding wheels for generation of complex shapes.
6. Automation is typically more affordable for a turning center rather than a grinding machine.
7. Super precision turning can expand turning capability to handle tight tolerance parts in the average machine shop.
8. Perfect complement for grinding houses with the ability to reduce production costs for some jobs.



HARDINGE SUPER-PRECISION®

At Hardinge, we offer industry leading SUPER-PRECISION® turning equipment for a variety of applications. Hardinge is a leading international provider of advanced metal-cutting solutions. We provide a full spectrum of highly reliable CNC turning, milling, and grinding machines as well as technologically advanced work-holding accessories. The diverse products we offer enable us to support a variety of market applications in industries including aerospace, agricultural, automotive, construction, consumer products, defense, energy, medical, technology, transportation and more. We've developed a strong global presence with manufacturing operations in North America, Europe, and Asia. Hardinge applies its engineering and applications expertise to provide your company with the right machine tool solution and support every time.

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