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HARD TURNING VERSUS GRINDING

When manufacturing hardened steels, when should you use hard turning and when should you use grinding in today's production? After the part is heat-treated, your options are limited, however, today's technology may be opening more doors than you realize.

First, we will see how hard turning is becoming more popular in today's manufacturing environment. Second, we will take a look at how technology is improving grinding to compete effectively in the current marketplace.

The Advent of Hard Turning

"One of the reasons hard turning is coming to the forefront of manufacturing is because people are trying to reduce the lead times it takes to get a part from raw material to the customer. It's a lean manufacturing initiative," explained Brian Ferguson, applications engineer at Hardinge Inc. "The thing you can do with hard turning, that is difficult to do with grinding, is you can start with a solid blank material and produce a finished component complete on one machine."

He noted there are several steps in traditional grinding that can take days to finish a part. Now hard turning technology can eliminate these steps.

"With grinding, you would typically rough the material on a lathe then send it to a heat treatment operation. Then you would bring it back and do several grinding operations to finish it. In hard turning, you start with a pre-hardened material and machine it. You can skip several steps and actually cut days out of the process."

In deciding if grinding or hard turning best suits your needs, Ferguson said you need to evaluate your requirements before producing the part.

"Choosing hard turning is really application driven," he added. "It's dependent on the part. Grinding is better suited if you have really thin walled parts or parts that are delicate from a crushing perspective. If you have a surface finish that requires a different type of texture, for example, when you turn you're creating a thread. When you grind, you get a checking. If you look at it under a microscope, it would be a pitted surface finish. When you hone, you get cross-checking surface finish. If this part has oil lubrication near it or running across the surface, the turned part would actually screw the oil through from one side to another. With grinding, the oil would be held there because it's pitted or cross-checked."

"Places where hard turning is very well suited is when you have complex figures, such as contour radii, angles and diameters all on one part. Hard turning can do that in one setting."

Besides the actual process and efficiency of hard turning, Ferguson said this type of machining is gaining popularity because the overall function is less expensive today.

Hard Turning vs. Grinding

Hard turning

"It's becoming more popular because hard turning is usually less expensive to do because it is faster, the machines cost less and operator learning curve is less. The operator has to learn the one machine and the one machine does it all."

While Hardinge specializes in grinding as well as hard turning, Ferguson said grinding is becoming more specialized. At the same time, hard turning also offers smaller benefits that can be time-saving and environmentally-friendlier.

"When you grind, you get a lot of fine particles. You have to clean it out and have a special filtration unit, which you have to clean regularly. With turning, you're producing steel chips, which are much easier to dispose of or recycle."

Although Ferguson said he has seen the hard turning market increase over the past several years, Hardinge recently released a new product that takes hard turning to a new level.

"HydroGlide takes our turning machine to a higher level of turning. It's a new development in the world of hard turning in the last couple years. It provides better damping and reduces vibration. Vibration causes the inserts to wear faster and hard turning inserts can be expensive. Parts we could not do two years ago because of this vibration, we can now do. Parts that had a lot of very aggressive interrupted cuts did not lend themselves well to hard turning and a shadow would form where the tool climbed in and out of the cut. Now we can produce these parts without the shadow, something we haven't been able to do before."

The patented HydroGlide linear guideway system is used on Hardinge's line of Quest CNC lathes. Unlike, conventional box ways, ball linear guides or roller linear guides, the HydroGlide system features no metal-to-metal contact. The guide trucks move on a thin cushion of hydraulic fluid under high pressure. The end result is zero guideway wear.

"One of the things I like to point out to people," said Ferguson, "is that machine structures are critical. The more difficult the part, the more important the machine construction becomes."

Which Way To Turn

As mentioned, there are still plenty of applications at which each hard turning and grinding excel. However, the material of the part that needs to be turned should be taken into consideration among other components.

"Hard turning will probably affect the sales of precision grinding machines but to a lesser extent than one might think," explained Mick Burdett, grinding specialist at SMS Machine Tools Ltd. "The problem with hard turning and milling is that it is structurally much harder on the material being machined. Therefore, especially for the aerospace industry, grinding will still be the finishing method of choice."

"Grinding will lose some high production jobs to hard turning and milling, but with the emergence of even more exotic materials and ceramics, grinding will survive and expand in the marketplace."

He added that technology is evolving the grinding process as well, which makes the process more efficient than in the past.

"Grinding has also moved towards CBN and SG wheels where little or more infrequent dressing is required," said Burdett. "Stock removals are just as good as hard turning in many instances. Also, many cylindrical parts and punches have 'none' round features and therefore must still be ground in specially configured machines."

Specialized applications such as fine finishes (below four micro-inch) will still require grinding as well as obtain roundness values of 20 micro-inches or better.

"Once a part is held in a chuck or collet, its roundness can only be as good as the bearing in the headstock. Usually the faster this is rotated then the roundness deteriorates. All Jones & Shipman cylindrical grinders, for instance, are tested for live spindle grind of 20 micro-inch or better. All Jones & Shipman surface grinders are tested to two micro-inch in the longitudinal axis and four micro-inch in the cross (z-axis)."

In addition, specialized materials are better suited for grinding than turning at this point.

"Grinding will lose some high production jobs to hard turning and milling," said Burdett. "But with the emergence of even more exotic materials and ceramics, grinding will survive and expand in the marketplace."

Effective Grinding

"In hard stage, you always used to grind. It takes a very long time as it's a very slow process," said Deo Persaud, hard department supervisor at Exacta Precision Products Ltd. "The industry has come up with hard edge hard turning so we can hard turn parts using a ceramic and diamond tools to finish the part in less than a quarter of the time it would take to grind."

Grinding specialist John Manley, of Machine Tool Systems,

Hard Turning vs. Grinding


Grinding

agreed with Persaud.

"Historically, you grind," explained Manley. "It's all you do after heat treating a part. It's just too tough a material to try to use conventional lathes and mills. So you would always go to a grinder, which can take considerable time. It's not a preferred method of finishing a part after heat treatment. If you could, you would always put the part on a lathe or mill because it traditionally takes the material off faster than a grinder will. Depending on how hard the piece is, what tolerance and what surface finish you want, you may be able to do hard turning or you may be forced to go to a grinder."

However, today's machinery can up the productivity of grinding hardened parts so grinding is again a viable alternative. It all depends on the user's requirements for his or her part.

Exacta Precision Products Ltd. recently implemented two Studer grinders to assist in finishing the part. Since implementation, the company has found increased productivity, decreased set-up time and lead-times for grinding parts.

"Today, the CAD/CAM drawing is sent electronically to the machine with little modification from engineering," said

Valuable VIT CBN wheel

Manley.

"Making a cam is a very long process," added Persaud. "Once the cam is made, you have to set it to make sure the cam is copying the part correctly. After you finish testing that, you can then put it into operation. You don't have to do that with Studer grinders. We get the drawing, it goes into the machine, loads it in and starts right away. You put a heat-treated blank in and away you go."

Studer's S32 was designed as a highly productive CNC external cylindrical grinding machine for small and medium-sized workpieces for production grinding. Fitted with special equipment, it can be used for efficient and economical grinding of form punches.

"In the past, one grinding wheel lasted three days," recalled Persaud. "Due to the implementation of Vitrified Cubic Boron Nitride (VIT CBN) wheels on our Studer, one wheel lasts about seven months. This saves about 80 hours of downtime over 40 weeks. It minimizes labor costs, machine expense and the lost ability to make parts."

Manley added this new concept is a just-in-time initiative that finishes a part, from solid heat-treated blanks, in less than 10 minutes.

"Instead of sending the punch to milling, turning, heat-treating, cam-operated grinding then finish grinding, now it comes right from a solid, heat-treated blank straight to the machine. Complex parts are now generated in a single machine serveral minutes, rather than hours, later."

A technological advancement is the grinding wheel itself. In the past, to adjust the hardness of the wheel, explained Manley, one wheel had to be taken off and replaced with another to suit the part.

"We make the wheel act differently by changing the spindle speed of the machine and CNC control. There is also a wheel change assist device so there is no risk in dropping a valuable VIT CBN wheel."

Studer's latest model, like the one at Exacta, also use high horse power so it can manufacture bigger hydro forming-style punches economically.

"Studer is much better than a standard CNC punch grinder," said Persaud. "Some punches took about 20 minutes to grind now they take about nine minutes to grind."■

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Hard turning