

Excerpts from Cutting Tool Engineering Magazine

CUTTING TOOL ENGINEERING

Vol. 63 | Issue 9
www.ctemag.com

Light Traffic

Magnesium auto parts
cut vehicle weight,
improve performance

Plus:

R_x for tapping medical parts

Waterjet cutting: Now in 3-D!

'High-density' workholding
ups productivity

Pointe Precision's machine
investment pays off

Fine touch propels
M&S Centerless Grinding



M&S hold tolerance down to 0.00002" on ground parts. Shown is a secondary diameter of 0.010" being ground on a cardiac guide wire.

A Fine Grind

Technology, experience and attitude breeds grinding success—on a very small scale

An eastern Pennsylvania grinding shop is combining high-tech grinding equipment, an enthusiastic and disciplined approach to problem solving and more than 50 years of grinding experience to handle the challenges of grinding microscale parts.

M&S Centerless Grinding specializes in cylindrical grinding including OD and ID work as well as parts chucked between centers. Meron Shegda's son John, who began to run the company in 1990 said the M&S focus is on centerless grinding and its derivatives. About half the company's business involves grinding microscale parts for medical applications including implants, hypodermic tubes, device components and cardiac guide wires. A quarter of the shop's work is what Shegda calls "ultra precision" grinding, mostly for aerospace and high tech customers that involves processing parts up to 0.750" in diameter with diameters tolerances to $\pm 0.5\mu$ and cylindricities to $\pm 1\mu$. General grinding makes up the rest of the shop's business including small parts such as 14" diameter minimizing industry bushings.

"We are all over the country and the world," Shegda said. "Many of our customers are in the Minneapolis area and Southern California. One of the medical jobs that is running right now we are exporting to China.

Centerless grinding involves a specific configuration of grinding wheels and workpieces. Traditional centerless grinders feature two parallel spindles placed side by side, one spinning a grinding wheel and the other a regulating wheel. The cylindrical workpiece is located between the wheels, supported by a stationary workblade.

The workpiece can be fed axially between the wheels in throughfeed grinding, or the grinding wheel can infeed (plunge) directly into the workpiece. Infeed grinding is necessary when a part requires a step or similar feature. Centerless grinding, especially for through-feed applications, is fast and precise, and beneficial where workpiece flexing would be a problem when grinding between centers.

Tight and Thin

Compared to grinding larger parts, small-part and ultra precision grinding “requires” a different mentality”, Shegda said. “To go from holding a tolerance of ± 0.0001 ”/“ -0.000 ” to $+0.00005$ ”/“ -0.000 ” is a big leap. Then, when you look at going from 0.00005 ” to 0.00002 ” total tolerance which we do, that’s an even bigger leap. You are testing the limits of the machine and what the process is able to achieve.

It starts becoming about how good the equipment is and how good the people are”.

Simply achieving a certain level of tolerance, however, doesn’t guarantee the next tighter level is possible. Shegda noted that over the course of a few months developing ways to grind the 0.0006 ” thick walls, he probably spent a week trying to determine how to get from 0.0008 ” to 0.0006 ”. “we’d try different ways to do it but the wall would break through. The part would just blow apart in the machine if I tried to go just a little further with it.” When reaching the limits of what the machine and process can do, he said, “you have to get really creative to figure out ways around that.”

The creativity includes a disciplined approach like a “science experiment,” Shegda said.

Taking a pad and pen onto the shop floor, he writes down every variable in the process, changes only one



Owner John Shegda (right) confers with Tony Aoun, work center supervisor and technical sales representative.

For example, in grinding pistons for a Minneapolis company, M&S holds cylindricity-roundness, taper and straightness combined to 0.00003 ”. “We are holding 0.00001 ” round, 0.0001 ” straight and 0.00001 ” taper total deviation,” Shegda said. “It is a very high-end application. To be able to squeeze that out is very, very difficult.”

Grinding thin wall tubing is an M&S specialty. The company recently ground 25-gauge stainless steel hypodermic tubing, 0.030 ” in diameter and 1” long, to a wall thickness of 0.0006 ”.

The tubes required a centerless infeed operation because the OD had a step; a small portion of the diameter remained at 0.030 ”, but the rest was ground at 0.025 ”. Although the wall was extremely thin, the ratio of diameter to wall thickness (about 47:1) was large enough that the tube was sufficiently rigid to grind. The tube wasn’t squashing,” Shegda said. “A 0.001 ” thick wall in a 2.00 ” diameter tube is way less stable than a 0.0006 ” thick wall at 0.025 ”, but a 0.0006 ” thick wall is so thin that even a grain of the grinding wheel breaking loose will dent it and make the part unusable.”

M & S developed a process to consistently achieve 0.0006 ” thicknesses. “It was not just figuring out the kind of wheel, the feeds and speeds needed but how to condition the wheel and how to work with the part that allowed us to be successful,” Shegda said.



A small sewing thimble looms larger over a selection of precision parts ground at M&S.

variable at a time and observes the results.

“We might change the truing or dressing of the grinding wheel, or we try running faster, slower, feeding harder or feeding slower.

We try all kinds of different things and look for the process to get better or worse.

It is almost as worthwhile to have a negative result as a positive one. “If you can make some kind of change happen, even if you make something worse, you now have something that is affecting the process,” Shegda said. If we can change that aspect and make it go a different way, it will make it better.

The company’s longtime and recent experience expedites process development. “We’ve learned quite a bit over the last 50 years, especially the last 10 because of the different challenges that have been presented to us.” Shegda said.

“Grinding that 0.0006 ” wall we used some techniques we recently learned in grinding plastic and they worked.

A True Machine

Differing machine configurations enable the shop to handle varying part requirements. M&S grinds a lot of tiny intricate parts on CNC Centerless DedTru machines from Unison Corporation. A DedTru machine basically consists of a centerless grinding fixture placed on a surface grinder. In a variation on the traditional centerless arrangement, the pair of wheels is turned 90° putting the regulating wheel on the bottom and the grinding wheel on top. A spring loaded pressure wheel holds the workpiece on the blade and against the regulating wheel. Then the grinding wheel is free to engage the workpiece.

Shegda describes a typical micropart ground on a DedTru machine: a 0.058" long, barbell-shaped locking pin that secures a clip onto a heart valve. The tiny pins were a big stumbling block for the device manufacturer," he said. The pins were ground from Elgiloy Co-Cr-Ni alloy rod, heat treated to 50 HRC. The 0.30" Diameter barbell ends had a relatively open tolerance, about \pm but the diameter of the shaft between them was $+0.0001"/-0.0000"$ (0.0191" to 0.0190" diameter).



The most difficult part of the project was grinding corner transitions from the shaft to the barbell ends which required a 0.001" maximum radius. "To hold a 0.001" radius is very difficult with a grinding wheel," Shegda said. "We ground the features on the end of a rod, then cut them off and figured out a way to face them." Holding the parts and achieving a uniform faced surface is a proprietary process developed by M&S.

The CNC DedTru machines employ toolroom-type wheels that are 7" to 8" in diameter and 1/4" wide. Much of the time, a rotary diamond disc dresses a form on the wheel and the wheel is plunged into the part to create the desired feature. But for certain features that require light feeds, M&S dresses the wheel to a shape that enables it to be applied like a lathe tool and interpolates the required form. Caution is required for heavy cuts however, where the wheel may wear and reduce the accuracy of the feature being ground.

M&S generally uses conventional abrasive wheels including aluminum oxide, silicon carbide and different grades of ceramics with different grits for different applications. "We run the gamut from grits as fine as 1,200 to as open as 46," Shegda said. "Most people think when you are using a 46 or 54 grit you are taking heavier cuts. But there are times you want to use a courser wheel, not so much with tiny parts as with plastics, because the coarser wheel prevents loading.

Equipment Decisions

A number of factors influence the shop's acquisition of new grinding equipment. The first consideration, Shegda said, is the market potential for the type of parts being ground. Second is the machine's flexibility: can it do just one or two things, or can it do a number of different things? Third, the equipment must represent leading or ground breaking technology.

Because we are a technology leader in the industry, we are able to solve problems that others struggle with," Shegda said. "We need to have the best equipment to be able to remain a leader. The micro work is a big growth area for us, especially in medical So we have to gear our machinery acquisitions toward that too. Our focus is to get better at going smaller.



Two examples of the tiny parts ground at M&S are a 0.058" long barbellshaped locking pin for a heart valve repair device and an H13 tool-steel core pin for a medical product mold which is 0.090" long with diameters of 0.003" and 0.012".



Actual photograph of a portion of M&S Centerless Grinding's factory floor containing Unison Model 2150 CNC DedTru Centerless Grinding Systems.