Cooling a tough straddle milling job

Saves auto parts maker $200K a year

Straddle milling can generate a lot of tool-sapping heat because two sides of a part are being machined at once. Cool things down, though, and everything runs better. Edges last longer. Production bottlenecks disappear, saving substantial dollars. That's the experience on U.S. Manufacturing Co.'s (USM) rotary transfer lines, which machine 445,000 forged steel automotive steering yokes a year in a 24/5 operation. By retooling all milling operations on the line, especially the overheated straddle milling step, USM has more than tripled edge life and pocketed more than $200,000 a year in machining cost savings.

The yokes are now rough-and-finish milled in a single pass with cooler-running Ingersoll positive-rake milling cutters. The changeout schedule has been stretched from once a shift to once every three or four shifts.

USM maintains a continuous productivity improvement environment to make sure that it stays competitive in the increasingly global auto parts manufacturing business. So the company is always on the lookout for opportunities that help keep a lid on costs. An integral part of it is the habit of seeking solutions and ideas from trusted vendors. At USM, there's no room for the "Not Invented Here" attitude anymore.

Even melted the paint

"The straddled milling operation ran so hot before, it melted the paint on the parts," says Dave Yambrosic, USM tool engineer assigned to the retooling. "Chips stuck to everything like bugs to flypaper." The paint and hot chips also stuck to the inserts, trapping even more heat and accelerating the cutting edges' demise. As a result, edges needed changeout every 300 to 500 parts, or once a shift. Worse yet, the toolsetter had to stone the paint off each insert before indexing. "It was definitely a bottleneck operation with overheating the root cause of insert failure," adds Yambrosic, "and our machine techs and toolsetters just hated the tooling."

So Yambrosic asked Ingersoll's Scott Tilton and Jim Brock for a remedy. It wasn't the first time. USM and Ingersoll have teamed up often to solve such machining problems before. "We just go back to the source who keeps giving us better answers sooner," says Yambrosic.

Wide, unsupported workpiece

The yoke is a wide U-shaped painted steel forging with uneven ears. In the finished automobile, the yoke holds the kingpin in place so that the front wheels can turn. The unevenness provides the camber and caster that helps the car drive straight. Width between the ears is about eight inches, about the length of a kingpin. The longer ear requires milling on both sides, thus the difficult straddle milling operation. The shorter ear is milled only on the outside, making things simpler. Workholding is difficult because the clamping surfaces have rough-forged finish and the ears are largely unsupported so clamps don't interfere with milling cutters' toolpath.

"In straddle milling narrow unsupported sections like these yoke ears, there are several problems to overcome besides the heat," says Ingersoll's Tilton. "First, the depths of cut on the respective surfaces may be uneven, making for uneven cutting loads and leading to part deflection. Heavy cuts characteristic of single-pass rough-and-finish milling can also cause vibration. So you need a very free-cutting tooling setup."

The old cutters used zero-rake, square, flat, coated carbide inserts, four edges per insert and the straddle milling operation required very heavy cuts.

V-MAX cutting tool and finished parts.

Dave Yambrosic (left) gages a finished part. US Manufacturing uses part tolerance and surface finish as indicators for indexing. With the new V-MAX inserts, tolerance and surface finish hold up at least three times longer, saving more than $200,000 a year in this high-volume operation.

Tilton suggested positive rake cutters with a finer pitch, a stepped set, and new wiper-style V-MAX inserts to make the operation run cooler. "Positive rake creates a gentler, cooler cleaving action to the cut," he explains. "By axially stepping the set of inserts, we divide heavy cutting loads between insert pairs. This all promotes freer cutting and lower cutting forces leading to less heat, less vibration, and longer edge life." The latest technology TiAlN coating on the V-MAX insert also resists edge buildup. Its formed top surface behind the cutting edges diverts the hot chips away for cooler running.

Also contributing to longer edge life is the wiper surface behind each cutting edge on the insert. "The wiper geometry, essentially an extended radius on the insert flank, creates a beefier, more wear-resistant cutting edge," adds Brock. "It extends tool life and also improves finish for a given feed rate."

The new straddle milling cutters, 8 1/2" and 9" effective diameter respectively, have a finer pitch than before. This reduces cutting forces per tooth and helps minimize vibration during machining in the unavoidably poorly supported ears. The smaller has 20 inserts vs. 7 before; the larger has 24 vs. 14. Both have stepped seat pocket design—alternate inserts are offset both axially and radially—to distribute the very heavy cutting loads.

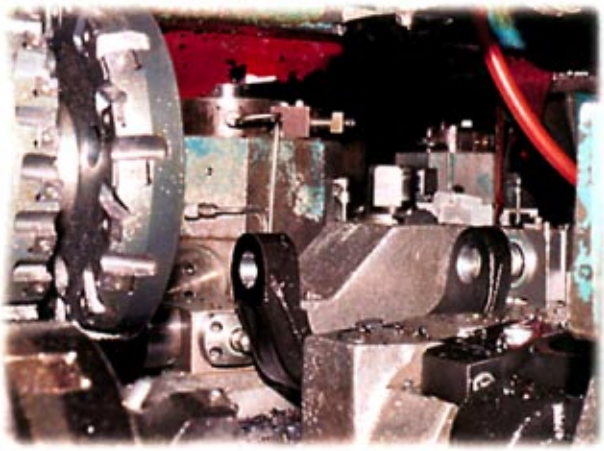
Comparison tests with the new cutters and insets projected an increase in edge life to 1,000 to 1,500 parts from 350. Adding in the lower per insert cost and the fact that the new double-sided square inserts provide four additional edges, this translates to an $115,000 annual saving in insert cost alone. Higher throughput, machine utilization, and edge life coupled with lower labor costs would increase the savings above $150,000 per year.

Exceeding projections

So USM went operational with the tooling switch and actual savings exceeded the projections. It was a drop-in replacement on two of the eight stations each on the three transfer machines. To minimize the retooling cost, Ingersoll modified the cutters' hubs to fit USM's existing arbors. Otherwise, all the new tooling was standard.

"When you factor in the lower labor costs and reduced production interruptions that come with a tripling or quadrupling of edge life, I'd estimated total savings from all sources at more than $200,000 a year," says Yambrosic. "Every time you can avoid a stoppage on a synchronous transfer machine, you multiply the savings, even though cutting rates remain as before. We're making 30 more parts a day because we don't have to stop so often for fresh edges.

"And our operators and toolsetters like the new tooling," he adds.



Paired Ingersoll cutters with V-MAX positive rake inserts to left and finished part in the center of completed straddle milling operation. Freer-cutting tooling took extreme heat out of the operation, extending tool life by more than 3 to 1.

Operations close up

USM runs the yokes on three identical 80-station rotary transfer machines. Each line's two milling stations have two sets of tools and arbors. Operators monitor tolerances and finish (±0.010"/492 rms) as indicators for tool changing. Even with these relatively relaxed tolerances, variations would reach the upper limit after only 300 pieces.

Arbor changeout time runs about ten minutes for the one-side milling operation and 15 to 20 minutes for straddle milling. Toolsetting time, done off line, runs about the same as before even though the new cutters have twice as many inserts each. Reason: the new V-MAX inserts need no stoning to remove built-up paint and no touching off. With the cutters' fixed pocket design, inserts track well within tolerance limits.

The improvement to USM's straddle milling operation stems from the combination of cutter and insert. It takes a combination of cutter seat angle and insert top face geometry to create the double positive edge presentation that promotes freer cutting and lower cutting forces. "You simply can't get such free, cool, low-force cutting action with old-style ISO zero rake cutters and flat inserts," says Brock. "And straddle milling, with its extreme demands, simply accentuates the differences that modern tooling can make on a production milling operation."

Though USM is currently running at 450,000 parts a year, their three transfer lines are designed to handle up to 600,000. "Now, as throughput increases, so will the savings from cooling off the straddle milling operation," says Yambrosic. **Ingersoll Cutting Tools, www.rsleads.com/406tp-234**