OCTOBER 2002 / VOLUME 54 / NUMBER 10

cover story

▸ BY BILL KENNEDY, CONTRIBUTING EDITOR

Let the Chips Fall...

Controlling chips with a laser-based process sheds new light on an old problem.

You don't have to solve problems that never occur.

That's the way AmeriChip Inc. looks at control of metalcutting chips. The Ann Arbor, Mich., company has patented a premachining part treatment that combines advanced laser, software and material-handling technologies to eliminate chip-control problems before an insert ever touches a workpiece.

In AmeriChip's process, dubbed Laser Assisted Chip Control, workpieces to be machined are scribed with a laser to a depth just above the final DOC, producing what the company calls an "engineered interrupted cut." AmeriChip says the delicate scribe has no effect on the finished part or cutting tool life, and unmanageable continuous chips never form because the cut is not continuous.

Problems with Chips

Many cutting tool geometries are extremely effective for controlling chips. However, the nature of some workpiece materials and machining operations can produce chips that are very difficult to break consistently. For example, mild- and low-carbon steels possess toughness and ductility that are invaluable in automotive powertrain components such as axles, shafts and hubs. Yet, those same properties make chip control problematic.

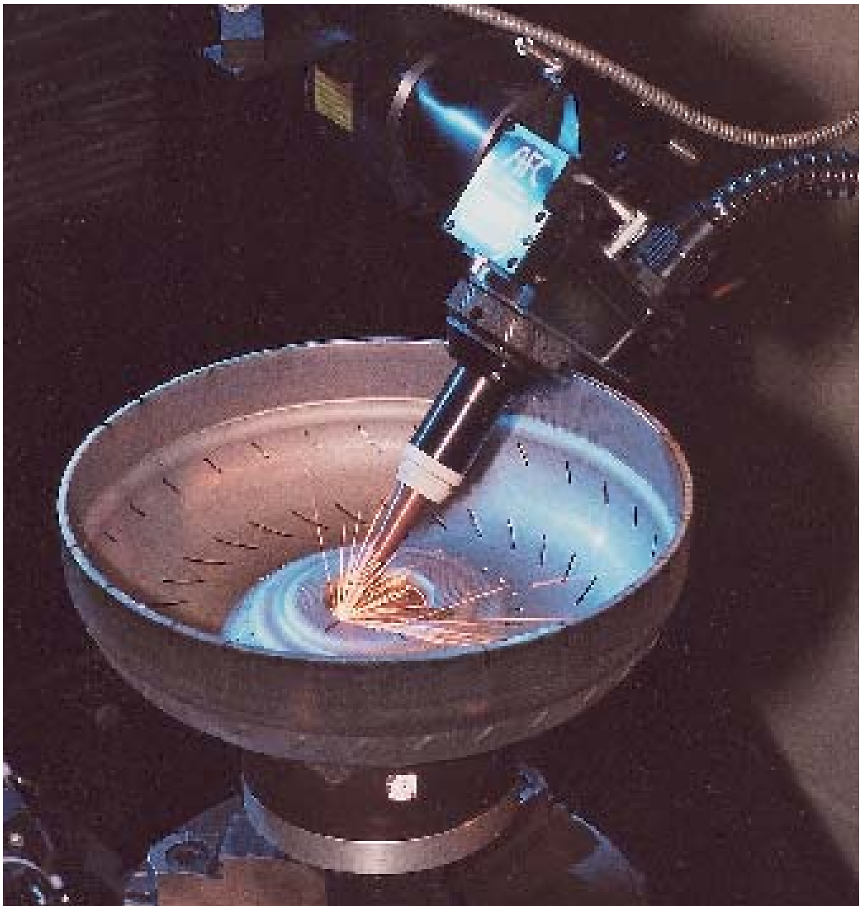
In addition, complex part contours can alter the relationship of the tool to the work and negate the effectiveness of even the best chipbreaker geometry.

High-feed strategies for chip control may only boost stress on the cutting tool and machine. Although machining parameters can often be fine-tuned to break chips, control may be spotty and can disappear altogether due to batch-to-batch variations in an alloy's makeup.

Poor chip control has myriad unsavory consequences. Foremost is the possibility of operator injury and damage to the workpiece, machine tool or cutting tool.

Many shops apply coolant to expedite chip clearance and extend tool life, but coolant brings with it disposal issues and employee health concerns.

AmeriChip CFO Marc Walther said the LACC process can eliminate the need for coolant. This is especially important because the costs associated with coolant use will likely increase.



All images: B. Kennedy

A stamped 1010 steel torque converter bowl for an automobile transmission is scribed by an Nd:YAG laser as part of AmeriChip's Laser Assisted Chip Control process. The laser is cutting 0.018"-deep notches into the part's thrust face. Notches 0.075" deep have already been cut into the bowl's rim.

"The federal government's efforts to tighten parts-per-million standards (the level of airborne coolant mist allowable in a manufacturing facility) will really drive dry machining," he said.

AmeriChip says another key advantage of the LACC process is it requires no changes to existing machining setups or parameters. Treated parts are simply loaded and machined, and stringy chips never form.

Reliable chip control can enable shops to take full advantage of automation technologies. One AmeriChip customer saw average per-part machining times cut in half after parts were treated. This was a result of eliminating the downtime needed to clear chips and because the absence of stringy chips allowed the company to employ robotic load/unload equipment.

Tool costs can be reduced through use of simple flat-top (chipbreaker-less) inserts, or shops can exploit the high-feed, fine-finish capabilities of wiper inserts.

Choice of workpiece materials can also be affected. AmeriChip President Dave Howard said the recycling expense resulting from chip-control problems prevented an automaker from using a specific aluminum alloy. In its research lab, the automaker determined that if LACC were employed, the coolant-free, short chips could be recycled at a profit. Some shops break an operation into multiple passes to control chips. Howard said the LACC process can eliminate that requirement.

Lighting Them Up

AmeriChip stresses that the process does not interfere with the dimensions or surface finish of the completed part. Scribe depth does not extend to what will eventually be the finished surface of the part, and laser power is controlled to minimize the heat-affected zone, so there is no unintended "heat treatment."

Typical laser-scribe depth ranges from 0.079" to 0.236". Scribe depth generally depends on part contours and how much material must be removed from the workpiece. Widths of the scribes average about 0.020" and can vary from about 0.015" to 0.050". Scribes can widen as laser parameters change to deal with hard-to-reach areas.

Although scribe depth does not reach what will be the part's finished surface, it does extend close enough to assure chip breakage on the final turns of the tool, according to the company. To handle dimensional variability in raw forgings, castings or stampings, the laser cutting head senses differences in a radius. That prompts an automatic parameter adjustment to achieve a deeper or shallower scribe, as necessary.

Out-of-spec workpieces are rejected, enabling the process to act as a premachining part-inspection operation as well.

A Team Effort

The executives at AmeriChip acknowledge the contributions others outside their company have made in the development of the LACC process.

AmeriChip has formed alliances with leaders in laser and material-handling technologies. One is with GSI Lumonics, Northville, Mich., a provider of laser-based manufacturing systems and components for semiconductor, electronics, precision manufacturing and telecom applications.

Programming the laser's path is not simple. "It's not just a matter of how fast we move across the part," GSI North American Applications Manager Tom Kugler explained. "We must modulate the laser based on the angle at which we're approaching, the alloy we're cutting and the depth we need to achieve."

Horizontal lines are scribed into a steel forging of an intermediate hub for an automobile transmission. The depth of the scribes varies from 0.032" to 0.265".

The Nd:YAG lasers that do the cutting vary in average power from 300w to 1,000w.

Getting the parts to the laser and positioning them accurately for the treatment is key to making LACC reliable and cost-effective. Meritage Manufacturing Solutions Central, Warrenville, Ill., a robotic systems integrator, has engineered 1,500 systems for a wide range of industries. The company is responsible for designing LACC robotic parts-handling packages. The role of robots varies according to the parts being processed. "Some of the robots will place the part in front of the laser," Meritage Sales Manager Ron Osowski said, "while others will carry and position the laser itself."

Creative Automation Inc., Ann Arbor, Mich., which designs gantry loading machines, conveyors, pick-and-place machines, palletizers and machine tool tenders, also collaborates with AmeriChip. Sales manager Bill McDonnell said AmeriChip's technology offers some special challenges. "Positioning the workpiece for the laser is critical," he said.

Where It's Going

AmeriChip is initially focusing its efforts on automotive powertrain-component makers because of the acute chip-control problems and long-run nature of those manufacturers' production. Walther said there are at least 18 parts in the average light vehicle that are clear candidates for LACC.

The following companies contributed to this article:

AmeriChip Inc.
(313) 341-8708
www.americhipmfg.com

Creative Automation Inc.
(734) 930-0050
www.cautomation.com

GSI Lumonics
(248) 449-8989
www.gsilumonics.com

Meritage Manufacturing Solutions Central
(630) 393-5700
www.meritagemms.com

The company is finalizing production agreements with a major automaker and a Tier 1 supplier.

An assessment of one possible customer's operation uncovered the potential for millions of dollars in cost savings from improvements in machine time, direct and indirect labor, tooling and materials, safety and environmental issues and capital spending, Walther said.

Future markets include nearly any manufacturing industry, including agricultural equipment, marine, oil patch, heavy equipment and aerospace. Later, when AmeriChip has set up strategically located processing plants, the company's focus may expand from high-volume shops to those handling lots of 500 to 1,000 parts.

Walther said AmeriChip is addressing the market two ways: First, as a supplier of pretreatment services for parts, and, second, as a provider of systems to carry out the process, subject to user fees.

Including the process as an internal machine tool accessory is not practical, Walther said, because machining and lasering in the same enclosure are not compatible. "You get the lens dirty," he said, for example. However, depending on the part being processed, nearly any 3-axis machining center or an articulated or straight-line rail robot can be adapted to carry the laser and/or workpiece on a dedicated, premachining basis.

Because the laser generates no tool pressure, a light-duty, stripped down machine tool—if it can hold required tolerances—can be adapted for the process. The cost of such a basic conversion can be as little as $40,000, Walther said, while "a high-production line with all the bells and whistles could be $1 million."

He stressed that the user fees, much like those levied by providers of coating equipment, would be in addition to the machine conversion costs.

Big selling points for the LACC process, Creative Automation's McDonnell said, are the safety and environmental advantages offered by reliable chip control. A major challenge for AmeriChip, he said, is finding its way through the organization of large manufacturers it initially is targeting. "AmeriChip has to get the large companies to look at the technology and overcome the 'not invented here' syndrome." △

An 8625-H alloy steel, scribed stem pinion for an automobile rear axle (left) and a similar part after machining. The range of the depth of the scribing is 0.005" to 0.026".