A Harder, Greener Cut

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While tooling may only account for five percent of the cost of producing a typical metal part, it can have an enormous impact on overall production efficiency, quality, and cost. Cutting tool consumers and manufacturers are considering emerging technologies, new tools, and new techniques to continue stay competitive in an increasingly competitive global marketplace. “We encourage all of our customers to climb the productivity curve,” says Don Graham, manager of Education and Technical Services with Seco Tools, Inc. “We want to see jobs stay here in the United States.”

Harder Materials

“We find a lot of attraction to very hard materials,” Graham says, “and we like to make cutting tools out of them.” While diamond is the hardest substance known to date, it also has its disadvantages. “You can’t do steels with diamond,” Graham explains. Aluminum, copper, wood, and granite can all be machined with diamond. The chemical reaction that occurs when diamond is used to machine ferrous materials “turns the diamond into pencil lead almost immediately,” Graham says. When it comes to hard steels, machinists need a hard tool. “The second hardest material that we are familiar with — that we can make into a cutting tool — is cubic boron nitride,” says Graham, “and there have been a lot of advancements over the last few years in that area.”

The primary advantages of embracing cubic boron nitride is that it can replace expensive grinding operations. “Grinding is a very expensive operation to run in a factory,” explains Graham. “If you could hard turn or hard mill as opposed to grind, you’d save a lot of money.” Cubic boron nitride may be the second hardest substance known, yet is also the second most fragile. Says Graham, “Because they are so hard, they are a little brittle.”

“And CBN is not cheap,” he adds, “but the overall cost is very favorable.” He explains that it is a mistake to look solely at the tool cost without considering the overall production cost of a metal part. “If you use this cubic boron nitride, the tooling cost per part produced is almost zero,” Graham says. “These tools last forever, relatively speaking. You buy an expensive tool, but you can run it for a month.” The cost advantages, over grinding, he stresses, are “overwhelmingly positive.”

Tougher Materials

Ceramic cutting tools are more moderately priced when compared to CBN, and the tool of choice in high speed applications. “Advanced ceramics have made inroads

into the tungsten carbide market, in niches that take advantage of the properties of the material and downplay the inherent disadvantage of the lack of fracture toughness," explains Thomas R. Shearer, general manager with Aggressive Grinding Service, Inc., a provider of tungsten carbide grinding and advanced ceramic finishing.

Ceramics are extremely resistant to heat (able to withstand greater than 4,000 degrees F) and are extremely hard and tough — making them ideal for jobs that require long run times or higher temperatures. Ceramics are often the tool of choice when working with superalloys, which exhibit high temperature creep resistance, stability, and oxidation and corrosion resistance. The industry is developing the first solid ceramic endmills, says Kennametal's Thilo Mueller, manager of solid carbide end milling, to meet the challenge in machining constantly evolving super alloys, which are demanding stronger and stronger cutting tools and are "a continual challenge."

"Where solid carbide tooling commonly runs at speeds between 65 and 200 SFM (20 to 60 meters per minute) with limited tools life in milling nickel-based superalloys, new solid ceramic endmills are presenting orders of magnitude improvements." These new ceramic cutting tools are roughing at cutting speeds up to 3,300 SFM (1,000 meters per minute), with tool life two to three times longer than comparable solid-carbide tools, Mueller explains, "allowing the ceramic endmill to run beyond the point where carbide tooling would need to be replaced."

"We have seen several different advanced ceramic materials being tested for use as endmills," adds Shearer. Ground zirconia is being used as plunger rods for high pressure AWJ pumps. Alumina is prominent in a variety of wear resistant parts. Boron carbide is being used in nozzle applications and silicon nitride in journal bearing applications. "And all have to be treated delicately," says Shearer. While whisker reinforced ceramics are making these stronger cutting tools, the main drawback of ceramic cutting tools continues to be their high fragility. "The materials are brittle," he adds, and require training on handling, measuring, and grinding techniques to avoid chipping and protect sharp edges.

Many factors are changing the world of cutting tools, including advances in machine tools, newly emerging super alloys, and the unrelenting drive to improve efficiencies and reduce costs. Says Mueller, "The results are productivity improvements, longer tool life, and an expanded range of applications for each new product."

Greener Materials

"Just about every tool we produce has to be compatible with dry machining," says Graham. "And more and more people are asking about it."

Dry machining is becoming more widespread because it is safer and more environmentally friendly, but also because the cost of coolant and disposal presents an area of immediate cost savings once a shop is able to turn to dry machining. In the typical machine shop, workers can smell the coolant, have to maneuver a

possibly slippery floor where the coolant has been spilled, and breath in coolant mist. Workers on the plant floor are routinely filtering coolant to remove debris, and also need to keep bacteria in check. “But eventually you have to dump it somewhere,” says Graham, “and that means a landfill.”

“The negatives to [dry machining],” points out Graham, “is if you have tight tolerances on a steel part, you’re going to have a hard time cutting that part dry.” As the part is cut, it heats up and expands. After being cut to size and left to cool, it becomes scrap if undersized. A freer cutting geometry that generates less heat is the technique most often used to compensate for this when dry machining explains Graham. Feeding the workpiece faster, at the cost of surface finish, is the least popular technique utilized to maintain tolerance.

But the world of cutting tools is always changing. As Graham says, “it’s an ongoing moving target.”

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