

Tooling Advances Drive New Product Designs

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Major manufacturers are eagerly adopting designs and production techniques that reduce the weight of their finished goods, in order to increase operating efficiencies. Aircraft builders have replaced stainless steel with carbon fiber-reinforced plastics (CFRP) materials to reduce the weight of their jets and planes. It's a switch that is improving fuel mileage and the crafts' durability because this product is much lighter and stronger than stainless.



The Vollmer erosion machining center measures the dimensions for teeth of a PCD blade.

A more obviously, example perhaps is automotive OEMs, who are aggressively seeking ways to reduce the weight of their products, in order to achieve better fuel mileage. For car and light truck engines, as well as for heavy equipment designs, the shift from gray or ductile iron to compacted graphite iron (CGI) is accelerating. It not only decreases the weight of the components but improves the structural integrity, too.

Replacing traditional materials with newer composites and alloys accomplishes various design and performance goals, but the new materials create additional machining challenges due to their hardness and the abrasiveness of the individual materials.

For example, silicon-aluminum engine blocks and transmission housings have enabled the producers to reduce the weight of these components up to 40% by comparison to their predecessor components. The inclusion of silicon metal in aluminum castings reduces tool life for existing carbide cutting tools and carbide-tipped saw blades. The price will be seen in the labor costs and production time lost to tool changes: some carbide tools may need to be changed 30 times for each tool, and some changes may take 1-2 hours to complete.

Replacing carbide blades

Polycrystalline diamond (PCD) tools and saw blades have successfully replaced some of these carbide cutting materials, increasing tool life, improving finishes and decreasing unit costs for the producers. [RKO Saw and Tool](#) manufactures and supplies carbide and PCD saw blades, and has had considerable success at converting its customers' operations from carbide to diamond tooling and saw blades. One particular customer, a producer of cast aluminum engine manifolds, realized a 30X improvement when converting from carbide to PCD saw blades.



A saw blade is loaded into a Vollmer erosion machine prior to finishing.

Three brothers established RKO Saw in the early 1970s, about the same time that polycrystalline diamond was developed and introduced to the metal industry. The second generation of owners, Ron and Carey Wiesner, took over in the 1990s, and the past 20 years or so have been paced by significant growth in the business.

The Wiesners attribute much of the growth to ongoing investments in new equipment and technology. For example, they have installed six robotic work cells to the operation, each one capable of unattended grinding to produce up to 150 saws. "This gives us a dramatic increase in capacity and reduction in labor cost," according to the Carey Wiesner.

Automation was introduced to to eliminate costs and reduce variability in blade processing. Carey states that purchasing the first piece of robotic equipment was the hardest decision he had ever made, but the next five choices were much easier. "The quality and consistency pays for the equipment over and over," he now realizes. The Wiesners' strategy of continuous improvement has helped RKO to become a leader in the supply of PCD tools and saw blades today.

The present operation in Cullom, Ill., covers 16,000 ft², with 22 employees producing and servicing 40,000 carbide and PCD saw blades per year, in addition to PCD tools. Although the average blade size contains 60 to 80 tips, RKO has produced PCD blades up to 36 inches in diameter for specialized applications.

The emphasis on growing the PCD blades portions of the business has been grounded in applications relating to aluminum casting. However, applications continue to evolve in industries as diverse as window manufacturing, printed circuit boards production, and construction of composite components for naval and aerospace equipment.

Successful conversions

RKO has been very successful at using its knowledge of PCD materials and tool designs to assist its customers to improve their plants' productivity. Four years ago, RKO successfully converted an engine manifold manufacturer from carbide-tipped saws (300 mm, 80 teeth, 4 mm kerf), to PCD tipped saws (300 mm, 40 teeth, 5 mm kerf). The manifold manufacturer uses the saw blades to remove risers and over pour on the finished aluminum castings.

"We approached the manifold manufacturer because of the success we had with a piston manufacturer," Carey explains. "The materials are similar and we felt PCD was suited to their operation."

"The end user was extremely hesitant about the change because of the initial cost," he continues. "We had to give them free samples just to get them to test. At that point the tools sold themselves and the engineer took full credit for the savings."

Using the carbide saws, the customer was averaging 1,000 parts per turn: once PCD blades were adopted, that average increased to 30,000 parts per turns, and now after further optimization of PCD grade and geometries they currently average 38,000 turns per blade. The 38X improvement in production also cut downtime associated with blade changes by a significant amount.

"The PCD blade does have a higher per unit cost of \$950 when compared to the \$145 carbide-tipped blade," Carey Wiesner allows. "However, the cost per part is reduced from \$0.145 with carbide, to \$0.025 with the PCD blades."

Due to the abrasive nature of the diamond or PCD portion of the tool, specialized equipment is required to shape or machine the diamond cutting edge. Traditional grinding can be used in the fabrication of certain diamond tools; however, the diamond grinding wheel wears quickly when tasked with grinding the PCD. As a result of this excess wear, erosion machines are the most cost-effective choice today.

[Vollmer](#) is the technology leader in this machine tool niche, with several types of equipment that use various rotary and wire erosion methods. "They can manufacture or sharpen just about any PCD tool that exists," according to Ron Wiesner. "We are constantly looking for new industries where we can introduce PCD tooling, and the Vollmer equipment is so versatile that there is no limit to the markets we can enter."

The erosion process takes advantage of the conductivity of the PCD layer to "arc" or erode the diamond, in order to obtain the desired geometry for the finished tool. In 2008, RKO invested over \$1 million in new capital equipment including erosion machines. "We first purchased a Vollmer QM ECO which can sharpen profile as well as straight tools," Wiesner now recalls. "Six months later we purchased Vollmer's QR and QF models, with robotic loading capability. This cell gives us the ability to erode the outside diameter and the side geometry of PCD saws with one set-up."

New applications for PCD

The Wiesners credit these investments and the PCD industry with sustaining them during the recent economic downturn.



Because of the high-wear rate of diamond cutting tools when cutting PCD blades, erosion machining is the most cost-effective finishing process for the blades.

As the manufacturers continue to develop new grades of PCD, additional applications are identified. These new applications call for finer grades of PCD that will be used with various grades of titanium; veined PCD drills and end mills that create major advantages in the aerospace and automotive industries; and some of the multi-modal grades destined for various solid surface applications in erosion. Knowledge and awareness of these materials continues to spread through the various industries where the applications lie, so the potential end-users worldwide continue to learn about their opportunities to become more competitive — thanks to PCD cutting.

Diamond has always been the hardest substance on earth, as most people realize. Their awareness of its excellent application as a cutting tool material continues to grow. And, the applications for PCD continue to emerge as production demands evolve and tighter tolerances are requested in all industries.

Demand for lighter and stronger products promotes the development of new materials that are more and more difficult to machine. Global competition increases the need for production efficiencies. And, opportunities for PCD tooling continue to grow, as forward thinking companies like RKO Saw lead the advance.