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Extreme Drilling

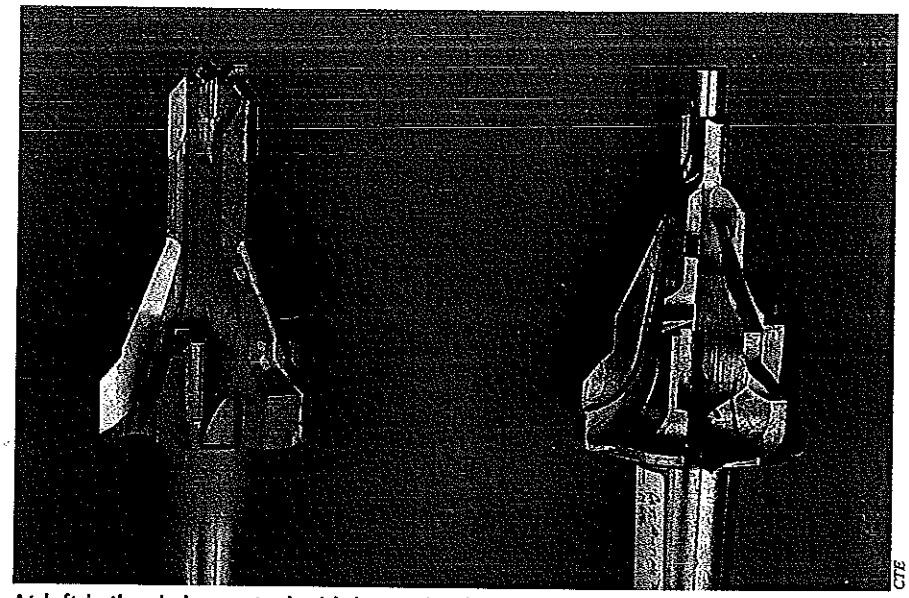
Caterpillar uses one tool to produce six features in a single pass.

A dedicated production machine can consistently outproduce a multitask CNC machine. But while a dedicated machine is able to maintain high production rates during lengthy part runs, flexibility is generally sacrificed for speed.

That's the case at Caterpillar's Lafayette, Ind., plant. The manufacturer of heavy equipment produces its 3500-series gray cast iron cylinder heads on a transfer line. The cored holes of the cylinder's valves are machined at dedicated drilling stations that run at a fixed speed and a fixed feed rate.

Over time, design changes to the cylinder head have required more features to be added to the cored holes. One of Caterpillar Tooling Engineer Russell Shoemaker's jobs has been to find ways to make the same fixed-speed drilling stations produce multiple-diameter holes that are chamfered and spotfaced. This has required him to utilize tools with increasingly complex designs.

He's gotten help from Hartland Cutting Tools Inc., Cary, Ill., a custom-tool maker specializing in subland drills. The long-term partnership between the companies has resulted in a highly evolved multidiameter tool that completes six operations in a single pass.



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At left is the six-in-one tool with inserts in place. The tool at right is in the "as-milled" state. The design of the tool has evolved over a period of time.

Design Limitations

Unable to modify Shoemaker's speed and feed specifications, Hartland had to create a design that would compensate for these fixed parameters. The dedicated drill stations operate at a fixed speed of 700 rpm and a fixed feed rate of 0.010 ipr, presenting a significant design challenge for Hartland Engineering Manager Rick Lucchetti. Plus, Caterpillar required that the tool make 800 holes between resharpenings.

This unique multidiameter cutting tool's body is made from M-7 HSS that's heat-treated to R_C 63. It incorporates a No. 3 Morse taper to accommodate the existing holders in Caterpillar's dedicated machinery.

The tool's body also features six subland-style flutes. The cutting edges for the multiple features are located along these flutes, at various depths.

In operation, the first job the tool performs is to cut a 0.748"-dia. spotface at the bottom of the 3"-deep cored hole. The spotface prepares the surface to accept a G-drill—also known as a square drill—which is applied at a subsequent drilling station.

Previous versions of the multidiameter tool incorporated solid-carbide cutting edges for each feature. But the fixed speed of 700 rpm only provided about half the required surface footage for the 0.748"-dia. spotfacing geometry. Running carbide slower than the recommended surface footage results in premature failure of the cutting edge.

When test-machining cylinder heads supplied by Shoemaker, Lucchetti found that the spotfacing portion of the tool lasted just 400 holes, or half of the production requirement. He solved the problem by grinding an uncoated spot-