How to Go Custom with Cutting Tools

by Pat Toensmeier - contributing editor, ThomasNet.com

A lot of machining plants use custom cutting tools, although the amount varies. For some, it's standard; for most, it's occasional, even rare. The question is: When should a machining operation consider custom over standard tools?

Here, Andrew Gilpin, business development manager of cutting tool manufacturer AMAMCO Tool, in Greer, S.C., discusses the factors that lead a shop to specify custom tools and the benefits gained from using them.

"Generally, if someone invests the time and [money] involved in a custom tool, he expects to see a reduction in production costs," says Gilpin. This can be achieved by longer tool life — which reduces machine downtime – along with reduced breakage and faster machining speeds.

If, for example, a standard drill bit has a life of 100 holes before it needs to be replaced, a custom drill should do 125 to 150 or more holes, he remarks. If a standard drill machines a workpiece at 2 ipm, a user might want a custom version to machine at 4 ipm.

Users of custom tools may also benefit from step production. Rather than use multiple tools for different steps in machining, the machinist can employ one custom tool for multiple operations — drilling, reaming and cold-forming a part, for example.

Occasionally, a custom tool has a lower per-piece cost versus a standard tool, but Gilpin says even if the tool is more costly than an off-the-shelf option, the overall project savings invariably defray the higher per-unit cost of the custom tool.

The process of developing a custom tool begins in the user's plant. Technicians come in and analyze the machining process or application and advise on the project savings that can be expected. They also evaluate the capabilities of the machining system for which the tool is intended, examine how the workpiece is fixtured in the setup process and assess the skills of the workers and machinists. "Sometimes a user's expectations can't be met," Gilpin says, "though it's rare that our toolmakers cannot reduce cost and production time through tool design."

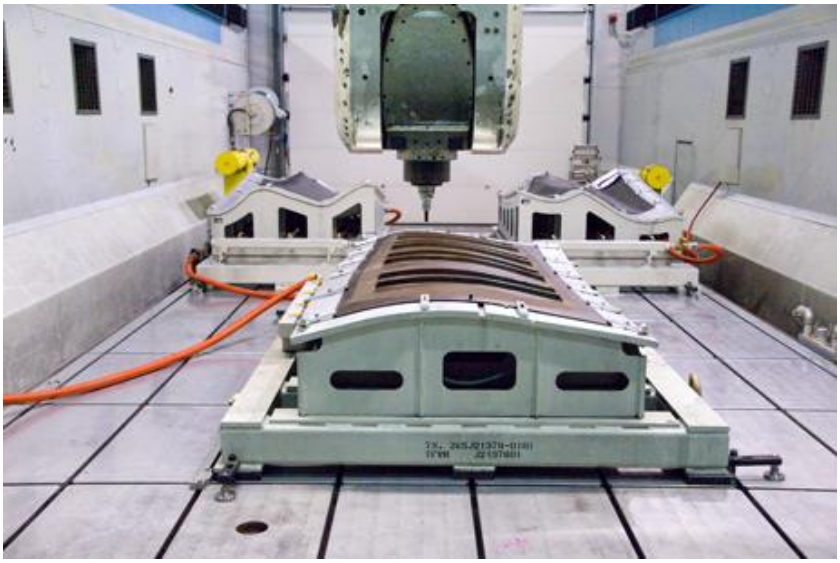
A custom tool can incorporate many design aspects — or a few. Sometimes it's as simple as increasing overall tool length. A machined part might require a 4.5-in drill rather than a standard 3-in drill. An outer diameter might be expanded or a corner radius increased. "Any change to the geometry of a tool beyond what comes off-the-shelf makes it a custom design," says Gilpin. More than 90 percent of the tools AMAMCO produces are custom.

Once a tool's design is set, technicians evaluate substrate materials and coatings. AMAMCO's specialty is solid carbide tools. Also specified are diamond coatings, such as chemical vapor deposition (CVD) diamond coating, which is preferred for machining hard carbon composite materials. Other carbide substrates achieve varying degrees of strength, although there are tradeoffs. A high-strength substrate might eliminate tool breakage during machining, thus improving productivity, but also wear faster, thus shortening tool life. Gilpin says some users are prepared to make this tradeoff to prevent downtime and quality problems from broken tools.

The price premium for a custom tool varies. Gilpin says the cost to replace a standard tool with a custom design could be a few cents or a few dollars per tool unit. But if the switch results in substantial productivity benefits, the additional cost is negligible.

Custom Tool Shaves Time And Cost for Stealth Fighter

One example of AMAMCO's ability to achieve productivity gains and, coincidentally, significant per-tool cost reduction through custom tools was the machining of wing skins for the F-35 Lightning II (also known as the Joint Strike Fighter). Developed by Lockheed Martin, the so-called fifth-generation stealth fighter is the most advanced warplane ever built. It is also, at an estimated procurement cost of more than $320 billion and lifetime (50 years) fleet upkeep cost of $1.5 trillion, the costliest U.S. defense procurement program ever.



To achieve its stealth or radar-evading property, the F-35's body and wings are made of a special carbon-fiber-reinforced polymer composite (CFRP), which is highly abrasive to machine. When Lockheed Martin began routing wing skins several years ago, it used polycrystalline diamond (PCD) tools. The CFRP was so abrasive that tool life was only 9 linear feet at one-third of material thickness. Moreover, the PCD tool was contributing to delamination of the CFRP skin. Lockheed Martin turned to the National Center for Defense Manufacturing and Machining (NCDMM) of Latrobe, Pa., for a better approach.

AMAMCO was one of the NCDMM alliance partners that worked on a new tool design for the aerospace company. Gilpin says that after AMAMCO evaluated Lockheed Martin's machining process, it developed the cutting geometry of a 0.5-in-OD compression router that would improve machining efficiency.

In tests, Lockheed Martin and NCDMM found that the new tool lasted 57 linear ft at full material penetration. Delamination was also eliminated. The compression router shank was made of solid tungsten carbide. AMAMCO also produces a diamond-coated version using CVD, which grows 100 percent pure diamond crystals onto the carbide shank.

The cost of the tool was 35 to 40 percent less than that of the PCD tool. Gilpin says this last benefit wasn't much of a surprise, since PCD is an expensive material.

The NCDMM project took nine months to complete and cost $105,000. The custom design reduces the number of tools needed per wing skin to two (one to rough, one to finish) from 24, increases productivity, reduces scrap and saves $80,000 in tool costs per aircraft. Lockheed Martin currently expects to build 2,443 F-35s for the United States alone, which would mean $195.4 million in savings from the custom tool design — a significant benefit for a program that is under intense scrutiny for cost overruns.

The router that AMAMCO helped to develop for the F-35 is now available to the general machining industry. Gilpin says that occasionally a custom design proves effective enough that other machining plants want it, and it becomes an off-the-shelf tool. "This evolution can take years," he says. But a design embraced by the high-volume auto industry, he explains, often goes from custom to standard in less time.

Any way you look at it, custom tools are a viable option in achieving lower production costs.