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➤ BY BILL KENNEDY, CONTRIBUTING EDITOR

Progress VS Production

With demand for aerospace parts booming, can machine shops risk using new technology to boost productivity?

Raptor endmills from Technicut are designed specifically for high-performance machining of titanium and high-tensile steels in aerospace manufacturing. Each tool consists of an HSS body with brazed-in carbide blades to provide a cost-effective solution for larger diameter/longer reach applications, where larger-diameter solid-carbide tools would not be financially viable and HSS tools would be too slow.

While the current airplane-building boom may be the best of times for aerospace manufacturing, some shops consider it the worst of times to adopt new technology and boost machining productivity.

Under heavy pressure to tightly control costs while providing complex, low-volume, high-quality parts just-in-time, it's easy for a manufacturer to say, "If it's not broke, don't fix it." However, shops that don't continually update their manufacturing equipment and processes may lose their competitive edge.

The U.S. aerospace industry is booming with production of products and parts up 22.1 percent in 2006. Demand for parts is high, and shops are facing capacity constraints. "The shops are machining critical parts, and they are leery about testing tools on them," said Michael Standridge, business development specialist/aerospace for Sandvik Coromant Co., Fair Lawn, N.J. While the largest manufacturers have in-house R&D departments to test and prove out tool performance, the "subcontractors, Tier 1 and Tier 2 suppliers don't have that internal capability," he said.

Cost containment efforts have prompted many shops to downsize internal capabilities, including manufacturing engineering. As a result, "the smaller subcontractors rely heavily on tool manufacturers in terms of proving out tools and working up process improvements," Standridge said.

Sandvik Coromant maintains a facility in Fair Lawn with machine tools and other equipment to facilitate part runoffs, tool testing and training for both sales representatives and end users. "Feature-based demonstrations, for example, determine the best way to machine a pocket out of titanium. We can extrapolate what we've learned from machining that one pocket to machining the entire frame beam," Standridge said.

Specialized Assistance

Intense aerospace business activity is prompting component manufacturers to seek specialized help in developing new materials and processes. One such resource is TechSolve, a Cincinnati-based nonprofit consulting organization that provides implementation of and training for lean manufacturing and other cost-reduction projects, and also supports the development and testing of advanced manufacturing tools and technologies.

Frank Gorsler, senior project engineer for TechSolve, has been involved in manufacturing for more than 45 years. He has found more resistance to new technology in the automotive industry than in aerospace. In automotive, "maybe it looks good in the lab, but they are not going to be the first one to try it in production. I don't think aerospace people are that way. They are looking for any edge to improve productivity." Large manufacturers especially, he said, "are most willing to evaluate new technology, and in most cases they have their own machining laboratories to do that."

However, when boom times stretch in-house research capability, even larger manufacturers employ outside help. Gorsler gave the example of an aircraft engine manufacturer that developed a new cast nickel-base alloy. "They came to us to determine how to machine it," said Gorsler. TechSolve first evaluated the baseline machinability of the material in basic operations like milling, drilling and turning. After also examining different heat-treat scenarios, TechSolve consulted with tool manufacturers to find the best tools to cut the material. "Then [the engine builder] asked us to model it and identify ideal operating conditions over a range of speeds and feeds and depths of cut," Gorsler said.

The next phase was machining an actual part, at which stage TechSolve itself engaged specialized help. The consulting organization has basic turning and machining centers and grinders, but not the large-capacity tools found in large manufacturing facilities. TechSolve supplied General Tool Co., a Cincinnati-based aerospace component manufacturer, with the basic machinability data and had it machine the parts. "Our role is to monitor what General Tool does, document what the fixtures look like, determine how many times they flip-flopped it and so on, and provide that information to the customer," Gorsler said.

Earl Wilkerson, supervisor of tooling and programming for General Tool, said the shop increasingly deals with new materials. Aerospace customers, he said, "keep trying to reinvent materials to push the envelope." He described the material being tested for TechSolve as "awful. It sort of cuts like a Rene." (Rene is a trade name for a class of nickel-base alloys.) Tests on the alloy included experiments in applying ceramic cutting tools to finish engine cases. "The problem is that you get the speed you need, but you don't get accuracy because you have wear. So we are trying some things to at least get the tool to last as long as it needs to cut the surface," Wilkerson said.

Sandvik Coromant

An aerospace component made of 718 Inconel is machined with a new ceramic SiAlON insert grade from Sandvik Coromant.

Gorsler noted, "The big concern is about residual stresses in the part, because you are going pretty fast. That may cause the part to warp, or if the insert breaks as you are turning across the flange, you may leave a taper [that wasn't specified] in the flange."

Wilkerson said the limited part runs characteristic of development work in particular and of aerospace machining

General Tool

This prototype engine stator case, made of Greek Ascoloy stainless steel, was machined at General Tool Co. on a 5-axis Deckel Maho machining center fitted with a right-angle head.

in general make it difficult to optimize machining processes. "Even on production jobs, we might do 50 parts in a year," he said. As a solution, General Tool developed software to collect and interrelate machining information. The software has tool and material libraries and NC strategy information, including speeds, feeds and DOCs.

"Say I wanted a 0.0015" radial DOC, going full depth of a slot in Inconel 718," Wilkerson explained. "If I pick a tool that has been used before, I can go to 'tool history' and it will tell me where it was used and what materials it was used in." For a similar part in the same material, the machining parameters will be the same. Operator comments on each job are stored as well, so parameters can be modified on subsequent jobs when appropriate. "We don't have to re-create the wheel," Wilkerson said, "It's made a job shop almost like a production facility."

Long-Term View

Some shops simply make time to test. Bill Aikman, plant supervisor, Crissair Inc., Palmdale, Calif., a Tier 1 manufacturer of aircraft fluid control components, said the current surge in aerospace business puts the shop under the gun to get parts out while maintaining top quality. Despite that pressure, Crissair takes time to work with suppliers to investigate new tooling technologies when appropriate. "We do because even if it might cost us a little bit of time in the short run, we

gain it back and then some in the long term," said Aikman. Time isn't specifically budgeted for testing. He said: "We can't afford to do that. We do it as need be or when new tools come on the market. We've got to play that by ear."

Crissair has a growing roster of about 7,000 active parts, said Aikman. The parts generally are not large. "It's rare that we get anything even 10" to 12" long; typically they are between 1" and 2"," he said. The parts generally are machined from stainless steel or titanium. Some are small enough to be produced on the company's Swiss-style automatic mill/turn machines, while larger parts are turned on Okuma lathes and milled on Fadal machining centers. Lot sizes are typically 25 pieces or less, made to meet JIT time frames.

Sandvik Coromant

Crissair Machine Cell Leader John Nixon, right, discusses part tolerances with Rich Stevens, representative of distributor DGI Supply of Sacramento, Calif., which supplies Sandvik Coromant tooling to the shop.

Jim Courtney, Sandvik Coromant productivity engineer, has worked with Crissair for about 2 years and said he's built a rapport with the shop. "They are always willing to let me test," he said. Aikman said applying the toolmaker's new 1105 grade, developed for turning titanium, let the shop boost machining parameters and reduce a 6-minute cycle time to about 4 minutes for a Ti-6Al-4V part. "We embrace anything that can help make parts faster and still maintain good quality," Aikman said.

Courtney said such openness to testing is not universal. "There are always those shops that say they don't have time; 'we've been doing it this way for 25 years, and we are not going to change.' I tell them I'm sorry about that; I think we could really save you some money."

Another way to deal with the productivity/progress conundrum is to add capabilities outside the production process. Bud Tyler is vice president and general manager of EF Precision Inc., a Willow Grove, Pa., shop that offers contract manufacturing, engineering, machining and assembly of custom mechanical and electromechanical components. "We are the 'breadbox-size and smaller' guys," said Tyler. "We'll handle things like parts for aircraft braking systems or small assemblies for a heads up display for some of the fighters." Last year, the shop produced close to 30,000 different line items, specializing in parts with tolerances of 0.001" and tighter, said Tyler.

In response to customer requests and to provide tool and process development capability, EF Precision will build a shop for making prototypes this year. Tyler said, "If we had a production job and somebody suggested that we use a new diamond or tungsten-carbide cutter, for example, we generally have not taken that risk." With separate prototyping capacity, "we will have a chance to experiment with new equipment and tools, and that testing can flow into our production shop."

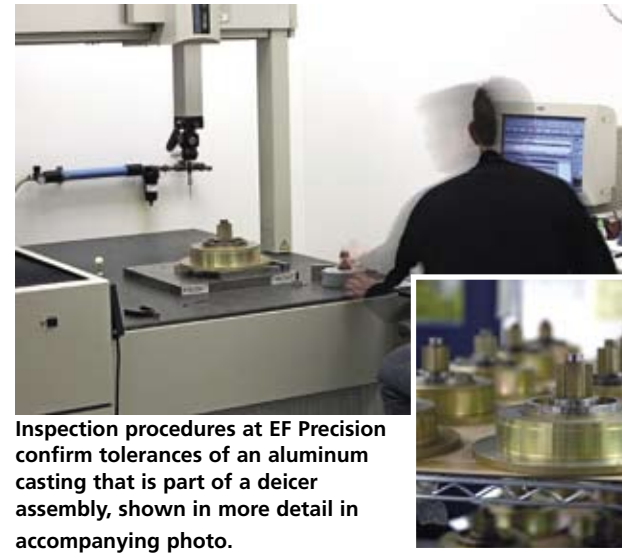
Partnership Benefits

Working with the right kind of customers can also open the door to productivity improvement efforts. "There are a few different types of customers," said John Cole, president of Sunnycor Inc., a Terryville, Conn., shop that serves the aerospace and other industries. "There is the customer that goes out and gets the lowest price, and it doesn't matter who it is." Another type of customer offers more of a partnership. "They want you to survive in business and be able to maintain a quality shop and produce a quality part," Cole said.

The second type of customer offers a give-and-take relationship, which frees Sunnycor from focusing totally on immediate costs, freeing up development time. "Using modern technology has cut down a lot of our times," said Cole. "We are able to make our customers happier because of it," he said, noting the lower cost per part and greater responsiveness that result from more productive processes. He admits that process development does have a cost. Cole said: "There's a certain degree [of interruption of production], but if you are just taking a new-design endmill and trying a faster speed and feed, you are going to know right away whether it is going to work or not. If you are trying a whole different system, that might be different. If it is going to take a lot of time, you have to weigh what you can afford to test and what you can't."

Creating a New System

Randy Von Moll, aerospace product manager at



EF Precision

Inspection procedures at EF Precision confirm tolerances of an aluminum casting that is part of a deicer assembly, shown in more detail in accompanying photo.

Sunnycor

A give-and-take relationship between Sunnycor and its customers enables the manufacturer to test and adopt new technology while producing a wide variety of aircraft components, some of which are pictured here.

Cincinnati Machine LLC, Hebron, Ky., said worldwide manufacturing is much more risk adverse today than in decades past.

"Twenty years ago, even the largest aerospace OEMs were in the habit of coming in, expecting blue sky, and taking what we could deliver against that requirement," he said. "Today, nobody wants to be first. They want proven technologies." Von Moll said that many employees in today's lean organizations are risk averse because lean initiatives pare down excess resources and reduce any margin of safety that might cushion against unexpected problems. Since capital investment costs are very-high for machines that produce larger parts, manufacturers will often choose only proven technology.

Machines developed for industry-specific needs are more easily accepted. In aerospace, for example, the continuing drive for lighter, faster, more fuel-efficient planes has engendered the increased use of new, higher performance (read "tougher to machine") workpiece materials.

Dan Cooper, Cincinnati Machine senior applications engineer, described the development of a high-performance horizontal machining center for aerospace applications. He said Cincinnati's HPC-800 HP machine was originally designed for the auto industry, with a high-speed spindle, dual ballscrews on linear axes and a rapid rate of 80 m/min. He noted that having ballscrews on both sides of the axis make for a much stiffer, higher performance machine tool. The HMC cut titanium effectively, so the company decided to market it for other difficult-to-machine materials, which are usually machined at relatively low spindle and cutting speeds. While most machines' torque and horsepower peak at higher rpm, Cincinnati Machine reconfigured the HPC 800, gearing it to maximize cutting capability at lower rpm. As a result, in its titanium-cutting form, the machine has a base cutting speed of 375 rpm and duty-rated torque of 845 ft.-lbs.

To assure that its machines provide maximum productivity, Cincinnati Machine partners with other suppliers when appropriate. An example is the company's relationship with U.K.-based Technicut Ltd., a designer and manufacturer of specialty rotary cutting tools for high-performance machining of aerospace alloys and composite materials. In a partnership, the Maintenance Technologies machine tool service and support group of MAG IAS (parent of Cincinnati Machine) represents Technicut in North and South America and China and nonexclusively throughout the rest of the world.

Technicut provides Raptor endmills to machine titanium and high-tensile steels, such as 15-5ph stainless. Each endmill consists of an HSS body with brazed-in carbide blades which, through a proprietary process, are twisted to high helix angles. When the endmill is applied, the helix angle produces a thin chip and permits feed rates to be increased significantly. The tools are typically used for finishing, where they can provide feed rates in titanium machining in the range of 1 to 2 m/min., quite high for that material.

Paul Graham, Technicut director of engineering and operations, said the HSS/brazed-carbide combination provides a cost-effective solution for larger diameter and longer reach applications, "where large-diameter solid-carbide tools would not be financially viable and HSS would be too slow." The tools, made in diameters of 1.5" and larger, are for external profiling of rigid components using a large axial cut. For titanium, the tools typically feature a 45° spiral helix in a left-handed configuration that sends the cutting forces back into the spindle or the machine bed. The vertical forces serve to stabilize the cut.

Graham said Technicut has found aerospace manufacturers' attitude of "I don't want to be first" to be apparent in many cases. In response, Technicut has worked with Boeing's Phantom Works advanced R&D unit in St. Louis to develop the Raptor tool and associated application parameters and process controls. "In this way, no customers need to be the 'first adopters' as the process is fully proven, and as long as the rules are followed, the success is already proven," said Graham.

Risk and Reward

Cincinnati Machine's Von Moll said that in aerospace manufacturing, balancing production demands with the introduction of new technology is "a challenge. You have to find good partners. Sometimes they are suppliers, and sometimes they are customers who are willing to accept more risk; they get reward for that risk. You have to get real creative with this stuff." △

The following companies contributed to this report:

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