Thinking in 5-Axes

Attention to Detail Spells Success.

Story and photos by Richard Berry

Countless machining businesses face the decision every day: whether to take the next big step and upgrade to 4- or 5-axis capability . . . or not. While the transition is a major rite of passage for most growing shops, for one wildly successful enterprise in San Diego, CA, it was never a question.

"We started right out doing 5-axis work," explains Steve Grangetto. "We never considered anything else. Our company is based on the concept that we can make accurate parts more competitively with 5-axis machining than others can with more traditional techniques, whether it's a high-pitch Inconel® impeller or a simple aluminum L-bracket."

Grangetto and his friend Chris Taylor co-founded 5th Axis Inc. in 2005—in a crowded space with a small desk and a solitary Haas VF-2TR 5-axis trunnion VMC. Today, the IS0 9001:2000- and AS9100B-certified company is one of the most sought-after engineering, prototype and production shops in Southern California. The shop's long list of aerospace, electronics and medical clients includes such industry icons as NASA, Raytheon, General Atomics and Amgen.

Why Five?

Both Steve and Chris are mechanical engineers with backgrounds in automation and manufacturing, so when they bought their first machine, capability and efficiency were key requirements.

"I saw my first 5-axis machine while working for a large electronics company," recalls Grangetto, "and was dazzled by its capabilities. I was equally struck by its potential to make all types of machining more efficient.

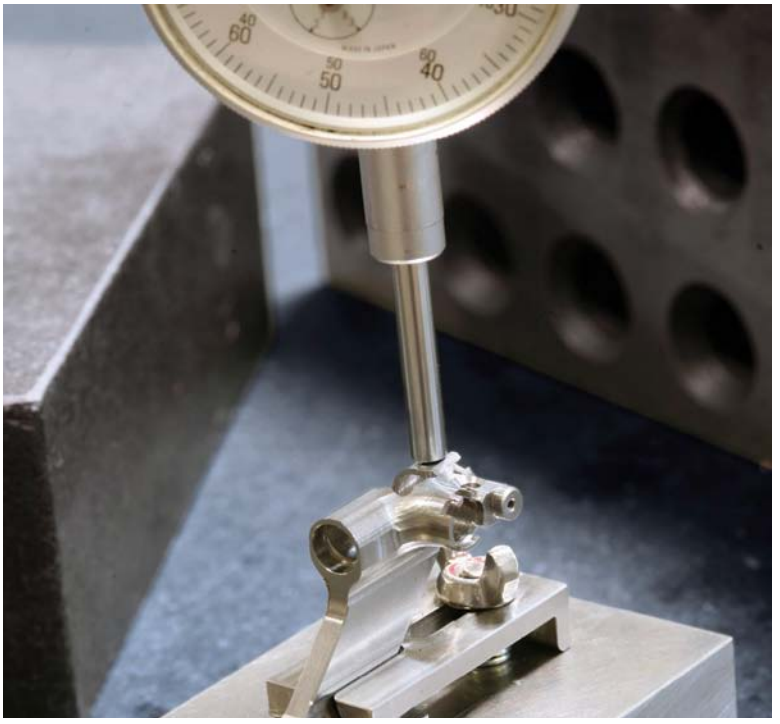
"Five-axis machines used to be the most expensive in the industry," he continues. "But when Haas Automation introduced a complete 5-axis machine for less than $100,000, Chris and I realized it was finally accessible for a start-up

business. We'd been talking about it for years, but Haas made it affordable, so we ordered the machine—a VF-2TR with a TR160 trunnion table."

The new company's name, 5th Axis Inc., made a bold statement in the market, and allowed Steve and Chris to immediately attract the kind of interesting work they were looking for. Besides getting the obvious work for parts that couldn't be made any other way, the shop's 5-axis specification allowed them to offer "single-mount precision" and streamlined one-op production—even for simpler projects.

"From the beginning, we stuck with our game plan," says Grangetto "and proved our initial concept was right: Critically accurate parts can be made more efficiently with 5-axis machining than with most other approaches. Besides streamlining traditional 3-axis work, we're also getting large-quantity work for parts that were previously thought practical only as investment- or die-castings."

Is there a secret to being so universally competitive with 5-axis work? "Well, there are no secrets to the 5-axis process," Grangetto assures, "just good, creative problem-solving. But we do pay close attention to a couple of things . . ."



Creative Fixturing

"Fixturing may be the ultimate in problem-solving," he continues. "If you don't start with a good, solid fixture—in either 3- or 5-axis work—you're not going to end up with a good part. More axes just add more layers of complexity."

"A lot of people still aren't used to thinking in 5 axes when it comes to fixturing," observes Chris Taylor. "They often design them to get a part on and off quickly, without stopping to think about clearance issues."

In 5-axis work, A- and B-axis movement can seriously impact Z-axis clearance. Careless designs invite costly crashes. Longer tools lessen some clearance issues, but introduce problems of their own.

"Whenever we use longer tools, we use balanced, shrink-to-fit toolholders to reduce runout and vibration problems," Grangetto explains. "We approach our fixturing and tooling issues from an engineering standpoint, as well as a practical machining one. Generally, shorter reaches and lower momentums are best. When the process demands longer tools or more massive fixtures, we pay very close attention to how they perform."

"On-machine probing is another valuable tool that Haas offers," notes Taylog. "Our machines are equipped with Haas probing that makes any setup easier, but when mounting irregular workpieces like castings, it's a 'must have.' We make probing a part of the program, so we just load the part and hit the button. The probe accurately locates whatever feature of the casting we've defined as a datum, and our machining stays extremely consistent. In these instances, we can use a simple fixture, just get the part close, and the machine does the rest."

"What we really like to do, though, is mount once, and clean up a part on all sides," Grangetto explains. "We'll eyeball a generous-sized blank to the edge of the fixture, then machine all around it in 5 axes to produce the part. Coming in from all five sides with just one mounting is a big advantage. Everything is established in one operation, and we never have to worry about initial mounting accuracy."

"We've designed—and are offering for sale—our own line of fixtures and clamps that are made to mount directly to the Haas trunnions," adds Taylor. "They self-center, and are installed with just a couple of bolts. And they have a low-profile design to maximize clearance and part size."

"When the fixture is right at the beginning," Grangetto continues, "we can let the machine take care of most other problems. But, there are one or two areas that require further attention . . ."

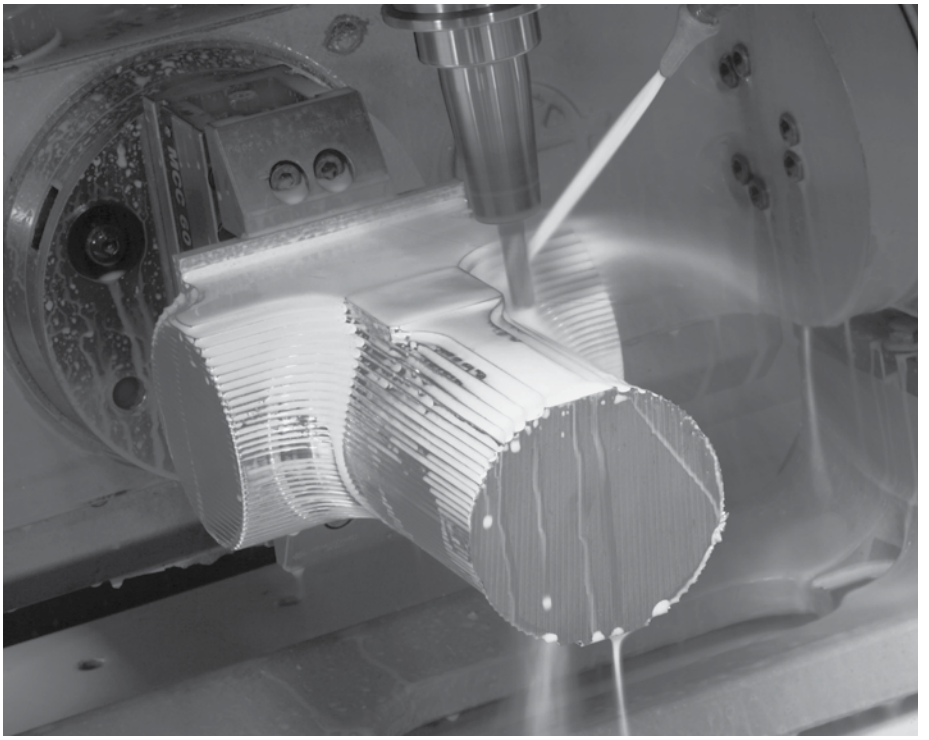
Tweaked Post-Processing

Today's CAM systems are very good. Like other "intelligent" software solutions, such as Internet maps or GPS navi-

gators, they usually get us close to where we want to go. “But any software’s ‘smartness’ about our particular situation is limited,” Grangetto observes. “When we increase machining complexity from 3 to 5 axes, we have to be much more aware of limitations, especially in the post-processing from the CAM program.”

The post-processor is a third-party software that translates, or interprets, between the CAM software and the machine.

“When working in 3 axes,” says Taylor, “there are usually one or two ways for the machine to get from point A to point B, and it is relatively easy for the post to translate that move to the machine. When working in 5 axes, however, there can literally be an infinite number of solutions to get from point A to point B, which makes the job of the post much more complicated. Even a proven post will occasionally generate a move that is unexpected.”



“Understanding your post is very important,” Grangetto stresses. “The CAM software will do what you tell it to do, but knowing how well its instructions post over to your machine—and what you must do to ensure the code is good—is vital. It’s often the key to running parts instead of running scrap!”

“When it comes to clearance issues, there’s the theoretical solution, and then there’s the real world,” Taylor adds. “We use verification software to accurately proof our programs in simulation—before we run them on the machine. Even with this capability, though, we don’t completely trust them; we walk through the process directly on the machine. It’s foolish to run the program before thoroughly proofing it.

“Knowing your machine is the other important part of knowing your post,” he continues. “High feedrates are a real test of a machine’s ability to accelerate both the table axes and the A and B axes in perfect sync. Any hesitation or slowdown in direction change is disastrous. At the very least, it smears the part’s finish; in bad cases, sync lag can destroy the tool and the part.

“We equip all our Haas machines with the high-speed machining package,” Taylor says. “Because the machine, trunnion, and look-ahead software are all designed at Haas, tweaks and adjustments are unnecessary. We just plug-in the trunnion and go; the interpolated motion is perfect. This arrangement can make the same simultaneous moves as a half-million-dollar integrated machine, but for a lot less money.”

“Our list of machines has grown from the single Haas VF-2 to a total of nine Haas VMCs, along with some other very expensive specialty equipment,” says Grangetto. “We’ve always gone the trunnion route on all our 5-axis machines. We especially like the robustness of the trunnion arrangement. It’s a solid setup. We can take heavy cuts – essentially burying the cutter—and there’s no vibration. The removable trunnion also makes the machine more flexible.”

“We have single-, dual- and triple-platen Haas trunnions, and we can mount any of them on any machine,” explains Taylor. “It gives us nice versatility, and having one common control that works the same on every machine keeps it simple. There’s a lot more complexity in 5-axis setup. If we had 4 or 5 brands of machines, each with different controls, it would create some pretty major headaches. Haas has gotten us to where we are, without the pain-in-the-neck.”

Standing Out instead of Fitting In

“Mostly, what we bring to the table is creativity,” offers Taylor. “That’s one of the good things about being new: We can be creative with our approach to a problem. We start with traditional machining fundamentals and solid engineering principals, and then try to push the limits with creative new approaches and aggressive strategies.”

“While a lot of shops are downsizing or shutting down altogether during this lean time,” Grangetto notes, “we’re on track to grow another 25 to 30 percent this year. I’d like to credit our somewhat unique 5-axis approach. It seems to have opened a lot of doors for us.

“It comes down to taking pride in doing something well,” he concludes. “It’s as simple as that.”

“And,” Taylor quickly adds, “it’s as complex as that.” ■