

Setting a standard

With flexibility and advantages, process becomes an industry staple

Initially developed in the 1950s to meet the demand for a new generation of parts, the five-axis machining center cut its eyeteeth on aircraft impellers, medical tools and appliances, customized cutting tools, and other applications that would be impossible or impractical to produce without five-axis capability.

Early five-axis machines were limited in function, difficult to program, and required excessive verification throughout the machining process. The lack of any standard controls and toolholders further complicated matters.

Today's five-axis machining center, with CAD/CAM programming and solid modeling, is a far cry from those early efforts. Such a center will allow five-axis machining simultaneously. Lessons learned in working with newer alloys have resulted in an emphasis on rugged construction. Control builders have evolved systems that are user friendly and easy to program.

Hermle Machine Co. of Franklin, WI, a subsidiary of Maschinenfabrik Berthold Hermle AG of Gosheim, Germany, was among the first to capitalize on the demand for five-axis machining.

"For many of our customers, five-axis was a natural next step," says Kenneth

Merk, executive vice president-sales and service. "Hermle has already had a reputation for producing ruggedly built and extremely precise machines.

"Twenty years ago, many of our units went into research laboratories and prototype facilities — the very people who were developing the first generation of today's complex parts. They were among the first to appreciate five-axis capabilities and, as we responded to their demands, we developed machines that were really ahead of their time."

Merk says as a result, five-axis became Hermle's particular market niche. In fact, for more than 10 years now, five-axis units have accounted for more than 90 percent of the company's sales.

Demand increases

Thanks largely to five-axis capability, Marten Machining Inc., of Stevens Point, WI, continues to grow and expand by serving the prototype market.

"The market for highly complex prototype parts continues to grow, and we found that five-axis is the only way to go to meet that demand," says Al Marten, owner. "We consider ourselves an extension of our customers' engineering departments and our products reflect that. Thanks to the flexibility of our five-axis machines, we're able to quickly turn out a wide variety of different prototypes and repeat parts.

"We receive all of our CAD files by e-mail and, seconds after it leaves the customer, we import it into our CAM system



As five-axis technology has matured and its popularity has spread, machine builders have begun to respond by moving "down market." This is Hermle's new B 300.

and input the data into our machines," Marten says. "That way, we can provide the fast turnaround that our customers demand."

Marten Machining has continually added to its lineup of five-axis machining centers and with the aid of a robot has linked two of them into an unmanned machining cell. Marten also operates two single-machine cells.

The ability to quickly generate complex parts in small batches through the use of five-axis machining centers has powered Essai Inc. to the top of Silicon Valley's Fast 50 list.

Founded by Iraj and Nasser Barabi to serve companies producing semiconductor chips, the company manufactures parts used to connect chips to the testing system and manage the chips throughout the process.

"Our largest parts are 6" x 2"," says Nasser Barabi. "Although most are in the 4" range, some measure less than 1" in size. Thicknesses are from .04" to 2", and materials include high-end plastics, copper and steel."

Extremely exacting

Machining is extremely exacting, as most parts require 20 to 30 operations and must be machined on four to five sides. Tolerances can be set as high as .0001



Iraj and Nasser Barabi of Essai Inc. continually re-engineer existing components.



and cycle times can extend from 15 minutes to three hours. On average, each part requires the use of about 20 different tools. Typical volumes range from two parts to several dozen per order.

To minimize external intrusion with the production process, Essai utilizes a fully automated system capable of three-shift production. Two five-axis machining centers equipped with 280mm NC swiveling rotary tables and tool magazines extended to 189 pockets are linked, via a pneumatic extension, with a pallet-handling system capable of storing up to 180 parts.

“Without five-axis flexibility, it would be impossible to accomplish what we do,” Nasser Barabi says. “Last year, we integrated 3,000 new designs into the process, and this year we expect to include over 3,600. Also, we are continually re-engineering existing parts and changing quantities.”

As higher production quantities across the spectrum of parts sizes have become a fact of life for five-axis users, builders have responded with a variety of solutions.

“At Hermle, our orientation has changed,” Merk says. “We once thought of five-axis in terms of the individual machine producing one part at a time, but now we’re much more involved in mid-level production quantities. For instance, our C Series utilizes compatible, proven features such as three-rail geometry, a heavy-duty trunnion table, and a mineral casting base to machine multiple five-axis parts in all size ranges.”

Merk says a variety of workholding options have been introduced for machining small parts or large oversized applications.

“Our pallet changers are designed to operate in stand-alone mode and to allow easy access when operator intervention is required,” he notes. “We’ve also developed strategic partnerships to provide fully automated systems that are part sensitive and cost effective.”

Growth in toolmaking

Not surprisingly, toolmaking is one of the areas in which five-axis machining has experienced phenomenal growth.

Great Lakes Custom Tool Manufac-

turing of Peshtigo, WI, produces cutting tools for the woodworking and metalworking industries. Although a high percentage of its work involves customized tooling featuring highly intricate profiles, the company has developed several patented proprietary lines that are produced in mid-sized quantities.

“Once you start with five-axis and see what it can do, you always want more,” explains Ray Martin, vice president of

operations. “We started with one machine and now have several. Everything we make is held by a shank or bore, and five-axis capability has really simplified setup time.

“This is especially true with some of our more complex tools such as helical cutters,” he says. “For other products, we’re able to do multi-sided machining in one setup.”

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five-axis solutions

Ease of setup has also been a key factor in moving to five-axis for TNT EDM located in Plymouth, MI. Originally founded as a dedicated EDM shop serving the plastics injection molding industry, the company added five-axis capability in 2000 and has since purchased multiple machines.

"Five-axis has fueled much of our recent growth, and we continue to add more machines," says founder and president Tom Mullen. "Once we saw the kind of things we could do, we started going after machining business, as well as EDM, and we've been extremely successful.

"We've also moved some of our EDM work to the five-axis line because we've been able to accomplish some of the jobs with up to a 30 percent savings in time."

Mullen has also found other ways to achieve savings in time and money with five-axis.

"When you're involved in hard machining, tooling is one of your greatest expenses, and we have to maximize tool life across the board," notes Leon Carpenter, project manager and program-

mer at TNT. "Five-axis delivers better accuracy and the ability to optimize cutter lengths.

"We've also achieved tremendous savings by putting three- or four-axis jobs on the five-axis machine. Because the five-axis is versatile enough to approach the part from multiple sides and angles, you can generally get by with a more simple fixture, and you also save on operator hours."

Microscopes needed here

Mark Plesnik of Owens Industries, Inc., in Oak Creek, WI, also discovered an instance in which five-axis technology outperformed his expectations.

Known primarily for extremely exacting applications involving small-sized parts (at Owens, microscopes can be found at the machining stations), Owens made the move to five-axis machining when challenged by an engineering company that had designed a fire suppression device for use in the oil industry.

"The part was considerably larger than most of our output and was made

of nickel alloy," Plesnik says. "Tolerances are extremely high, and surface finish is crucial where two parts meet to form a seal.

"The part is turned prior to machining, and we realized that the only way to hold accuracy and complete operations in a reasonable amount of time was to minimize the number of setups. That could only be done with five-axis."

Prior to contacting Owens, the customer had been unable to find a company willing to produce the parts in quantity — much less at a reasonable price.

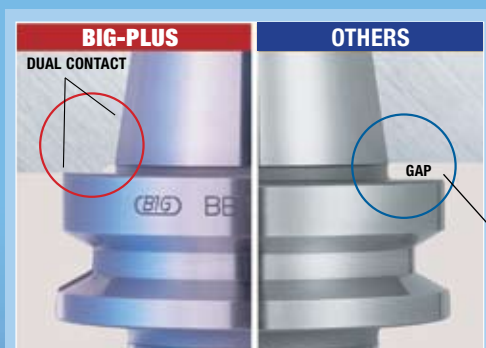
By refining the program, Plesnik and his team were able to complete machining operations including milling, horizontal and vertical drilling, tapping, and profiling in one setup. They were gratified to discover that they had achieved an 8-micron finish on the seal without lapping — thereby eliminating other operations.

Machining time was 4.5 hours, but as Plesnik states, "Without five-axis capability, it could take more than twice as long and necessitate multiple set-ups."

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As five-axis technology has matured and its popularity has spread, machine builders have begun to respond by moving “down market.”

“We know that there is a large potential customer base that is quality conscious but more price-sensitive than our traditional buyers,” Merk says.

To meet the needs of that market, Hermle now offers the B 300, called an

entry level Hermle, that incorporates many of the design features found in the C Series machines in a modular standardized package. The B 300 is priced at just under \$300,000.

As five-axis has revolutionized much of the technological side of manufacturing, it has had an equal impact on the concept of justification. When large-volume orders were the norm, the cost

of a machine was typically justified over the volume of the parts run.

“Most of our customers can’t financially justify a machine on the basis of a single order, but they know that five-axis parts are the shape of the future,” Merk says. “And, if they’re going to succeed, a quality machining center is the price of admission.” **Hermle Machine Co., www.rsleads.com/806tp-178**

Integrate a five-axis machine to maximize its effectiveness

Companies are finding advantages to five-axis machining centers not offered on traditional three-axis machines — for example, no more multiple setups across several machines. In return, this often streamlines workflow, improves productivity, and reduces the chance of inaccuracies.

Five-axis machining can also be a plus for tool performance. Rotate a part along the b- and c- axes, an operator maximizes efficiency of the tool’s angle efficiently and improves surface finish. Tool life can be boosted by up

to 60 percent this way. Quality, as well, improves.

Even training has taken on a new face. User-friendly CAM software packages that support five-axis are easily available, and tool-path-verification simulations help eliminate the risk of interference between any components within the machine. Operators well versed in three-axis programming often can make the transition to five-axis within one week of quality training.

New ground is constantly being broken in five-axis machining, and companies

need to find the latest information. Mori Seiki, for example, recently introduced the NMV8000 DCG with DD (Direct Drive) Motors on the axes. Compared to the servo-motors and worm gears used on previous five-axis machines, DD Motors eliminate backlash to improve accuracy.

The evolution of five-axis machining has provided companies a tool that with correct integration could increase their competitive advantage in the global market. **Mori Seiki, www.rsleads.com/806tp-180**

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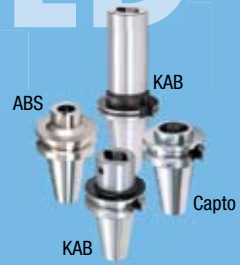
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