Application Story: IMTA—Today's HSM applications require better control from every angle

One importer going the extra steps to help

Three factors in today's high-speed machining applications effect overall performance and these conditions make the control scheme critical for product designer, machine tool builder and programmer alike.

New materials, including high-strength aluminum alloys and titanium, continue to emerge in the aerospace and semiconductor segments, posing greater cutting challenges.

Complex and thin wall part geometries, owing to the drive for monolithic structural components and reduced assembly time, are requiring a combination of high-volume metal removal and speed with accuracy. Tooling and workholding fixtures become more crucial.

Lastly, the conventional CNC lacks two critical features, namely, rotational center point and programmable tolerances.

Before examining these three factors, let's define high-speed machining in this aero-space/semicon arena:

HSM is a machining process combining high feedrate and acceleration of the machine with high power and high speed on the spindle to obtain high metal removal, extreme precision and good surface finish.

Now specifically, some of the particular challenges of the three factors above play large roles in determining the best solution in large machining centers.

On an aerospace part such as the AFT bulkhead shown in Fig. 1, the job involves machining aluminum 7075T6 with walls and floors with a thickness up to .026". Over 97% metal mass removal is required here. Cut on a Huron five-axis mill, with a dedicated post-processor designed by IMTA, the Rockford, IL machine tool importer, this part involves licensed proprietary HSM development and training.

As IMTA President Tino Oldani explains, "We reviewed the particulars of the job with our customer and we quickly realized the key was controlling the motion to a better degree. Our engineers devised a cutting program which optimized the stiffness and rigidity of the machine, the tool and workpiece fixturing, the electrospindle and all speeds to produce the best part in the least time."

"For this machine", Oldani continues, "we needed a control which had superior flexibility, and could manage the dynamic performances of the machine. We considered every major brand of CNC on the market, but ultimately preferred the Siemens SINUMERIK 840D, for various reasons. The NURBS (Non-Uniform Rational B-Splines) interpolation and the TRAORI transformation orientation feature, which aligns the cutting path based on work-piece position, not the pre-programmed machine reference points, were real upsides."

Above: Thin wall and deep pocket sections of aerospace parts are handled easily, with speed and accuracy unavailable in previous generation machines.

Huron KX200 five-axis machining center with fixed gantry, moving table and Siemens SINUMERIK 840D CNC with dedicated post-processor.

In practical terms, the smoother surface finish, elimination of chatter marks and improved overall cut times required by aerospace contractors drove the decision made by IMTA to use this type of control.

Thin walls and flooring in deep pockets can create further difficulties in cutting such parts. Head orientation and rewinding limits must be integrated quickly for all directional path changes required on such jobs. Here again, data overload can often slow down conventional CNCs, especially those based solely on the pre-programmed conditions. Changed in tool length alone can adversely effect cutting performance. Look ahead, feed forward, high processing capability, simple NURBS (without TRAORI) and even most large RAM and Ethernet systems lack the capability to rotate the tool center point adequately or to efficiently implement programmable tolerances.

As Oldani further explained, TRAORI signals up to the full three- or five-axis transformation, even with a 900 angle head cutter. It changes the control based on reference points in the actual work envelope and it does so in real time, thus radically improving speeds.

On one semicon wafer processing vacuum chamber, cutting time went from 600+ hours down to 95 hours. This is shown in Fig. 2 and the workpiece is being cut on a three-axis Rambaudi moving column, high-speed milling center. The program for positioning the taper tool is also run by a Siemens SINUMERIK 840D, with a post-processor engineered by IMTA.

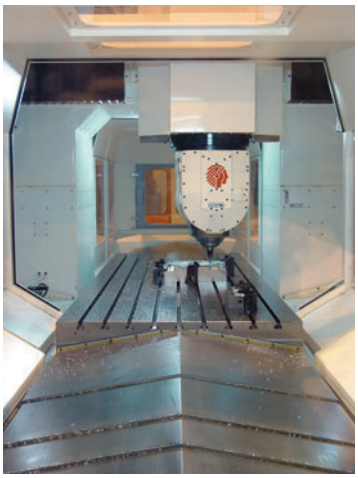
As part of its value-adding service to customers, IMTA configures the optimum HSM protocol and performs test cuts at its 44,000 sq. ft. facility in Rockford, IL, where a number of three- and five-axis machines are used for demos and actual run-ups for customer training. As IMTA President Tino Oldani explains, "We provide workable and sustainable solutions to our customers, often producing the first production parts for them in our facility to validate the proposed method of high-speed milling technology. Full programming, tool balancing and application engineering are provided in-house, as are spindle repair and service."

80% of IMTA's business is aerospace, though the company has installed equipment at automotive, semiconductor equipment and off-road equipment manufacturers, as well.

On the business side of this relationship, the Siemens Manager for International Business Development, Massimiliano Arrigoni, interfaces with IMTA and the machine builders in Europe, where Siemens delivers the control and drive packages directly to the OEM. Arrigoni observes, "We have enjoyed a very dynamic business environment at IMTA, where the full capability of our company is utilized to help our customer develop his expertise in HSM and bring it to the marketplace." Arrigoni is based in Chicago at the Siemens Machine Tool Business headquarters. His key contact at IMTA is Director of Operations, Donato Cigalla.

In addition to the SINUMERIK 840D CNCs, IMTA outfits most of its machining centers with SIMODRIVE 611D drive and linear motor packages. On the long runs of aerospace structures, as well as large vacuum chambers used for semicon wafer processing, HSM is enhanced by 1FN3 linear motors. Their advantages in positioning, acceleration, deceleration, rigidity, backlash avoidance and especially braking are well documented.

Owing to these onboard improvements of their machine brands, which also include Henri Linée, Pietro Carnaghi, Innse-Berardi and PAMA, IMTA has recently delivered a machine for the semiconductor industry, where the acceleration/deceleration and trajectory achievements resulted in an 88% reduction in cutting time. "This single machine has substantially increased our customer's ability to gain market share in the highly competitive semicon industry," says Tino Oldani, President and founder (in 1983) of IMTA. ■



Aerospace parts cut on Huron 5-axis mill benefit from unique transformation orientation of the machine's post processor.

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