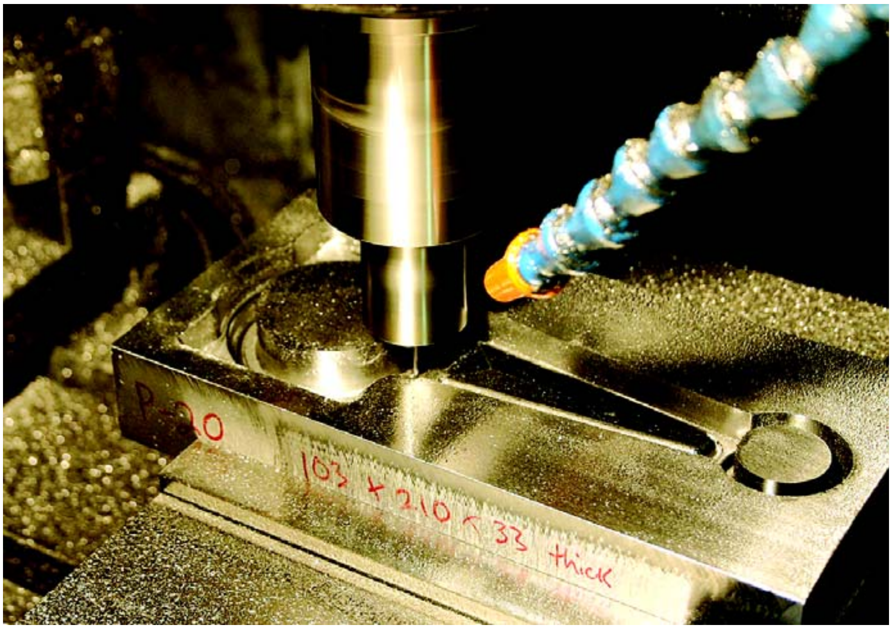
Is your HSM investment paying you dividends?

By Edwin Gasparraj
CAM Product Planning
UGS

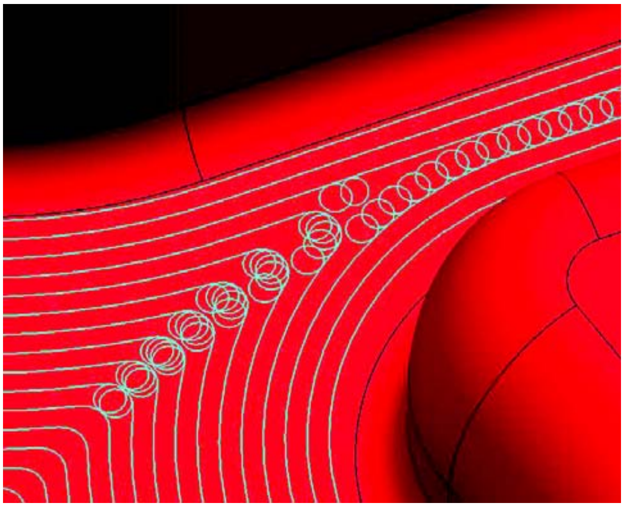
Global competition is forcing the mold-making industry to re-think the way it does business. Despite investing millions of dollars in high-speed machining (HSM) technology, firms for the most part have yet to achieve the true potential of hard milling processes for machining intricate molds and dies. Bypassing EDM and directly machining hard materials while achieving the planned productivity levels is still an unrealized goal for most mold shops.

Tool breakage and poor finish, among other issues, have forced manufacturers to slow their machines down, resulting in lost productivity and increased costs.

The major investment components of HSM are machines and controllers, cutting tools and holders, and computer-aided manufacturing (CAM) software. Vendors of all three components have made significant improvements to what they offer; however, little has been done until recently to integrate all three components and provide an effective, unified solution. All three components must work together to achieve the laboratory results that make HSM such an attractive process. The CAM system must move the tool around in such a way that it takes full advantage of the machine and tooling. If the CAM system cannot work in concert with the machine and tooling, the shop will come up short of the full promise of its HSM investment.



Direct machining of hard materials such as P20 reduces throughput time compared to EDM.

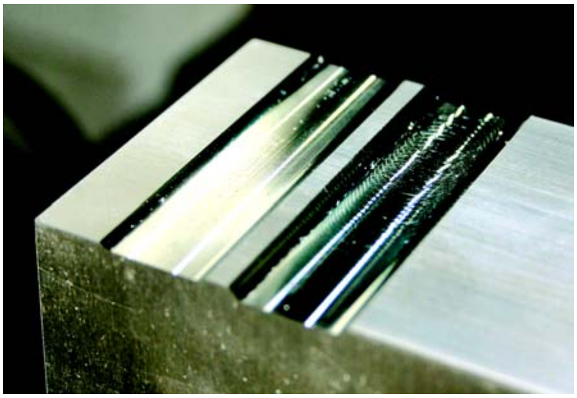

Optimized trochoidal pattern prevents tool from exceeding intended metal removal rate.

In the course of the research that led to the development of NX 3 High-Speed Machining capabilities, UGS (Plano, TX) studied shop floor issues such as resonance chatter, machine hesitation, and non-uniform tool loading—areas that cause tool failure in a hard milling environment. Most of these issues are traditionally left to the customer to resolve. By matching the CAM system to the needs of the machine and tooling, UGS has advanced the state-of-the-art in HSM tool paths and increased the ability to reach the full potential of the machine and tooling.

Constant metal removal rate

In a typical pocketing routine, the tool is fully embedded when it first enters a closed cavity or a channel. The tool is also loaded more than intended at the corners. Peaks in the metal removal rate cause early tool failure. This forces machinists to reduce machining parameters and results in lost productivity.

A constant metal removal rate is a very important criterion for high-efficiency machining. An optimized trochoidal path in NX 3 Machining en-



Two cuts with same metal removal rate. The wavy surface finish is the result of chatter. The smooth finish was obtained at chatter-free spindle speeds, which also extend tool life.

sures that the intended metal removal rate is maintained throughout the toolpath.

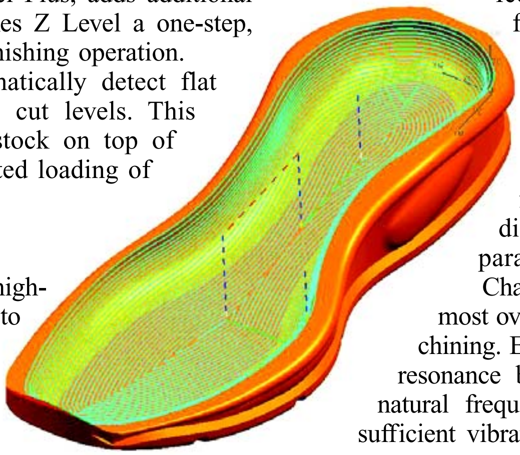
In order to maintain uniform cutting in hard milling, it is necessary to ensure that uniform stock is left after each tool in the machining process. Typical constant Z level operations leave unwanted stock on shallow regions that cause intermittent loading of subsequent smaller finishing tools. A new routine in NX 3 Machining, Z Level Plus, adds additional toolpath in these regions. This makes Z Level a one-step, HSM-friendly semi-finishing and finishing operation.

Roughing routines in NX automatically detect flat areas in mold cavities and adjust cut levels. This ensures that there is no residual stock on top of these faces that could cause unwanted loading of subsequent rest milling tools.

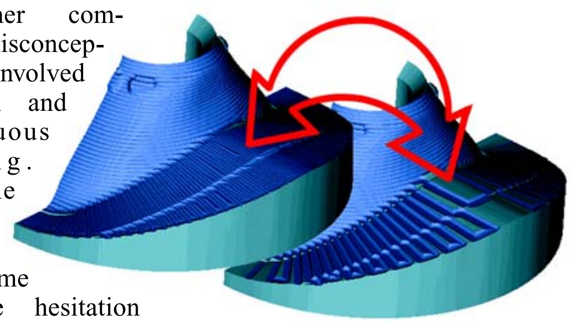
Truth or fiction?

Getting polished finishes from high-speed machining is the trickiest thing to do. This is the second area of opportunity for cost savings that most mold shops pass on. Horizontal machining operations typically produce excellent finishes because of the operation's inherent ability to maintain the desired cutting speed and vertical engagement angle between the tool and the blank being machined.

However, some geometry features require a smooth, consistent finish along steep and shallow areas of the cavity. This calls for a specialized toolpath that follows the geometry of the part and is equally spread in both steep and shallow areas.



Equally distributed toolpath along steep and shallow regions.



Z-level-Plus provides additional toolpath in shallow regions for consistent finish.

Another common misconception involved toolpath and continuous cutting. Machine operators often blame machine hesitation and jerky movement on the controller's inability to handle large amounts of data. Contrary to this popular belief, high-speed processors within machine controllers analyze data and choose whether an exact positioning or a smooth interpolation is intended. If the toolpath information is not distributed correctly, it could cause the machine to misinterpret the data, resulting in short jerky moves. NX 3 Machining's toolpath is designed to run the machines at high feedrates.

Chatter free machining data

Identifying machining parameters such as spindle speed, feed, depth of cut, and other tool-loading factors is important to high-speed machining. Most machining departments depend on their most experienced machinists to come up with these numbers. While this may have worked for conventional machines, factors such as resonance chatter can dictate optimum high-speed machining parameters.

Chatter is both the most important and the most overlooked phenomenon in high-speed machining. Even when everything else is optimal, the resonance between the cutting frequency and the natural frequency of the tool assembly can create sufficient vibration to break the tool. Current methods for detecting and avoiding chatter are experimental and require additional equipment that is too expensive for most mold shops.

UGS' search for optimum cutting data resulted in a (patent pending) process for identifying chatter-free HSM parameters. Machining parameters obtained from the chatter avoidance process machined a mold cavity in seven minutes that used to take more than 20 minutes—a performance improvement of nearly 300 percent. **UGS**

For more information:
www.ugs.com
800.498.5351