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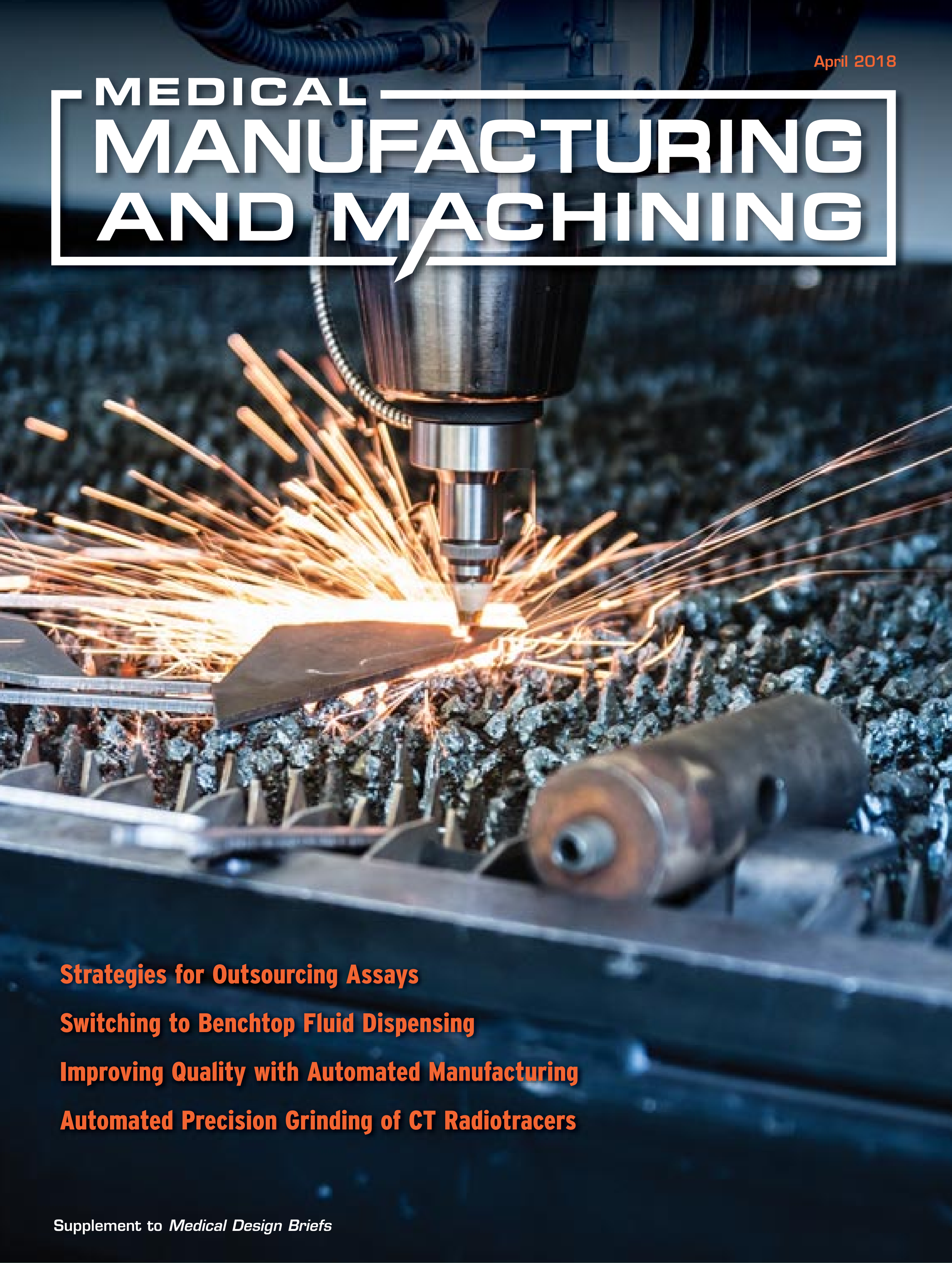

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Supplement to *Medical Design Briefs*

Running Titanium and Other Exotic Metals at Faster Speeds

High-speed machining is typically used in medical equipment manufacturing where machinists often work with exotic alloys and harder metals like titanium.

A properly balanced toolholder in the spindle is always important, but as RPMs reach 20,000, 30,000, or even higher, the precise and secure seating of a properly balanced toolholder in the spindle becomes even more critical. At these rates of speed, even minor flaws in toolholder fit or concentricity can lead to less-precise machining, reduced tool and spindle life, and even damaged workpieces.

Machining exotic alloys and hard metals also takes its toll on cutting tools, which must be changed out more frequently as they dull or break. The cost of tool replacement, not to mention loss of production time due to frequent changeover, can add up quickly as well.

All of these factors serve to slow down machining cycle times — the measure of the time it takes to complete each part from start to finish.

Now, however, an increasing number of manufacturers of medical parts and components are improving milling productivity of titanium and other metals by 15–20 percent by resolving one of the most fundamental and long-standing problems in machining: improper seating of the toolholder in the spindle.

For an industry in which cycle times are directly related to operational costs and, by extension, the bids offered by prospective customers, finding new ways to decrease machining time can lead to a significant competitive edge.

The Flaw in the System

The flaw in the design and utilization of retention knobs in tapered toolholders secured by drawbars, such as the popular V-flange, dates back to the original designs first introduced decades ago.

Perhaps because the shank and spindle are so carefully machined or because the industry has used retention knobs on tapered products for decades, this issue has largely been overlooked.

The shank of tapered toolholders is ground to a fine finish within very precise, established tolerances, and they are also threaded at the narrow end to accept a retention knob. The knob is designed to engage with the drawbar, which exerts a pull force that holds the toolholder firmly in the spindle.

The problem is that, when tightened, poorly designed, traditional retention knobs — a part that costs less than $30 — create a bulge in the taper that prevents proper seating in the spindle. Once this expansion occurs, the toolholder will not pull fully into the spindle and so it cannot make contact with upwards of 70 percent of its surface.

The results are manifested in a wide range of CNC milling issues often attributed to other causes: vibration and chatter, poor tolerances, non-repeatability, poor finishes, shortened tool life, excessive spindle wear and tear, run-out, and shallow depths of cuts.

For Janos Garaczi, president of Delta Machine Company, this meant addressing issues with the interface of toolholder and spindle on new high-RPM/high-torque equipment he installed. The company, based in Gardena, CA,

The High Torque retention knob installed in a toolholder. The knobs are longer to reach deeper into the threaded bore of the toolholder.

Toolholder wear is often attributed to other causes.

machines titanium products for the aerospace and the medical industries

To address the issues, Garaczi used unique High Torque retention knobs along with dual-contact spindles designed to keep the toolholder rigidly in place during high-speed machining. In doing so, Garaczi says the combination of equipment and machining expertise has decreased cycle times as much as 40–50 percent, allowing Delta Machine to often outbid the competition for projects involving titanium.

A More Aggressive Approach

Delta Machine specializes in high-volume production precision machining of complex, tight tolerance parts out of titanium, stainless steel, aluminum, plastics, and exotic alloys. Because the equipment involved a high-torque, high-speed spindle, Garaczi says the CNC manufacturer recommended investing in a unique retention knob for use with harder materials like titanium. Standard, off-the-shelf retention knobs could be used but were at some risk of shearing off or breaking due to the high torque involved.

To accomplish this, retention knobs are used. However, newer CNC milling machines exert significantly more drawbar pressure on the knobs than in the past. Moreover, most retention knob manufacturers provide little information on the proper torque required, a factor that can lead to the improper seating described earlier.

As a result, retention knobs can literally be pulled apart during operations. It's a significant issue because if the retention knob comes apart while the machine is running, it could cause considerable damage. If spindles are damaged, the costs can be considerable given that each spindle can cost $10,000 or more, not including the cost of any downtime.

"They recommended we use these specific High Torque retention knobs because there were scenarios where the high torque could tear off the retention knob and destroy the spindle," says Garaczi.

High Torque Retention Knobs

Invented by the company's founder, John Stoneback, JM Performance Products, Inc. (JMPP) High Torque retention knobs are longer by design to reach deeper into the threaded bore of the toolholder.

As a result, all thread engagement occurs in a region of the toolholder where there is a thicker cross section of material. It also includes a precision pilot to increase rigidity, and it is balanced by design. The product works with all existing toolholders including BT, DIN, ISO, and CAT toolholders from 30 to 60 taper.

Since even overtightening of the high torque retention knobs can still create a bulge, the company provides specifically calculated torque specs based on drawbar pressure.

By combining the high torque retention knob with the correct torque, spindle contact with the taper is improved to close to 100 percent every time, significantly reducing vibration and chatter.

This can be verified by simple six-step "touch off" test.[1] More sophisticated measurement of toolholder expansion (bulge) can also be taken using a taper shank test fixture.

The solution can even provide V-flange toolholders with the rigidity and concentricity necessary for high-speed machining of titanium, aluminum, and other metals/alloys without having to turn to HSK or Capto tooling systems that are 2–3 times more expensive.

Although the high torque retention knobs cost a little more than standard options, Garaczi says he would not take the risk of using another alternative. In the medical industry, price is a factor, but medical customers are more interested in top-quality parts delivered on time.

To further maximize the rigidity and minimize vibration, Garaczi specifies machines that have dual contact spindles. In this approach, both the toolholder shank (taper) and the flange are used to eliminate pull-back in the spindle. However, most machining operations do not use dual contact and instead rely on the interface between only the taper and spindle.

Tool Life

Perhaps more than some other industries, medical component manufacturing can take a toll on the carbide cutting tools used when machining exotic alloys and hard metals. The result is that cutting tools must be changed out more frequently as they dull or break. With higher-end multi-flute end mills and technical carbide inserts, these costs can add up quickly while also costing time for frequent changeovers.

By increasing the rigidity of the toolholder at higher RPMs, the retention knob can increase tool life. According to Garaczi, with titanium, most shops run about 50 in. per minute, with tool life typically reaching 1.5–2 hours before replacement.

"With the High Torque retention knob, we are running 100 in. per minute in titanium, and our tools last about five hours before we have to change them, which is pretty incredible," says Garaczi.

The other advantage was a better surface finish, which eliminated additional benching operations that add to the cycle times.

"Usually at the feed rates and speeds that we run titanium, the typical finish expected is 125 [rms]," says Garaczi. "The retention knob helps achieve a 50 rms finish at more than 100 in. per minute, which often exceeds what the customer requires."

In addition to increasing productivity, Garaczi says the decreased tooling costs and setup times can increase revenues that more than justify the cost of High Torque retention knobs.

The ROI on High Torque Retention Knobs

Although the product costs nominally more than a traditional retention knob, at a conservative 10 percent increase in productivity, the ROI can be as little as three weeks. At a 20 percent increase, the ROI can be achieved in a week or less. Furthermore, manufacturers running 24/7 or having to add extra shifts to meet production demands could scale back, if so desired.

With so much to gain, the issue may be simply lack of awareness. Although manufacturers are already benefitting from implementing the high torque retention knobs, many consider it a competitive edge, so they keep the information close to the vest. Others remain unaware — even dismissive — that improper seating of tapered toolholders in the spindle is even a problem that has far-reaching effects on machining.

Reference

1. Toolholder Test, JM Performance Products, http://www.jmperformanceproducts.com/toolholder-test.aspx.

This article was written by Jeff Elliott, a Torrance, CA-based technical writer. For more information, visit ***http://info.hotims.com/69505-204***.

Medical Equipment Enclosures: Automated Manufacturing Improves Quality, Speed of Production

Most medical diagnostic and testing equipment involves some type of enclosure, cart, or cabinet that serves as a user workstation or protects sensitive electronics, controls, and hardware. Although not as sophisticated as the actual diagnostic device itself, these enclosures are nevertheless critical to the use and overall service life of the finished product.

However, there is often more to forming these types of enclosures than meets the eye. The ability to create component parts with tight tolerances ensures that individual components fit and work to the design intent. Selecting the correct finish for the application is another important factor.

Even the precise placement of electronics and hardware requires careful consideration. The cabinet or cart must allow for easy use and movement by the operator, and its design must take into account any other ergonomic considerations. A good design also provides ease of maintenance and repair, as well as accommodations for future upgrades.

To accomplish this, medical device manufacturers may turn to contract sheet metal fabricators for the enclosure, which enables them to concentrate on the core device or diagnostic technology. For production-level quantities, this often means utilizing contract manufacturers with highly automated capabilities.

Highly automated manufacturing capabilities such as painting, welding, and laser cutting are ideal for production-level quantities.

In addition to speeding production, this approach provides a significant benefit when producing medical enclosures: increased precision of the component parts, often at a lower cost. Some sheet metal fabricators even provide full assembly, packaging, and direct-to-customer shipping of the enclosure with all of its other component parts. This article looks at the path of a cardiac platform cart through the manufacturing process.

Soteria Cardiac Platform

Soteria Medical, a medical device company based in Miama, FL, employed the automated processes of a contract manufacturer to improve the production and precision of the cart for the