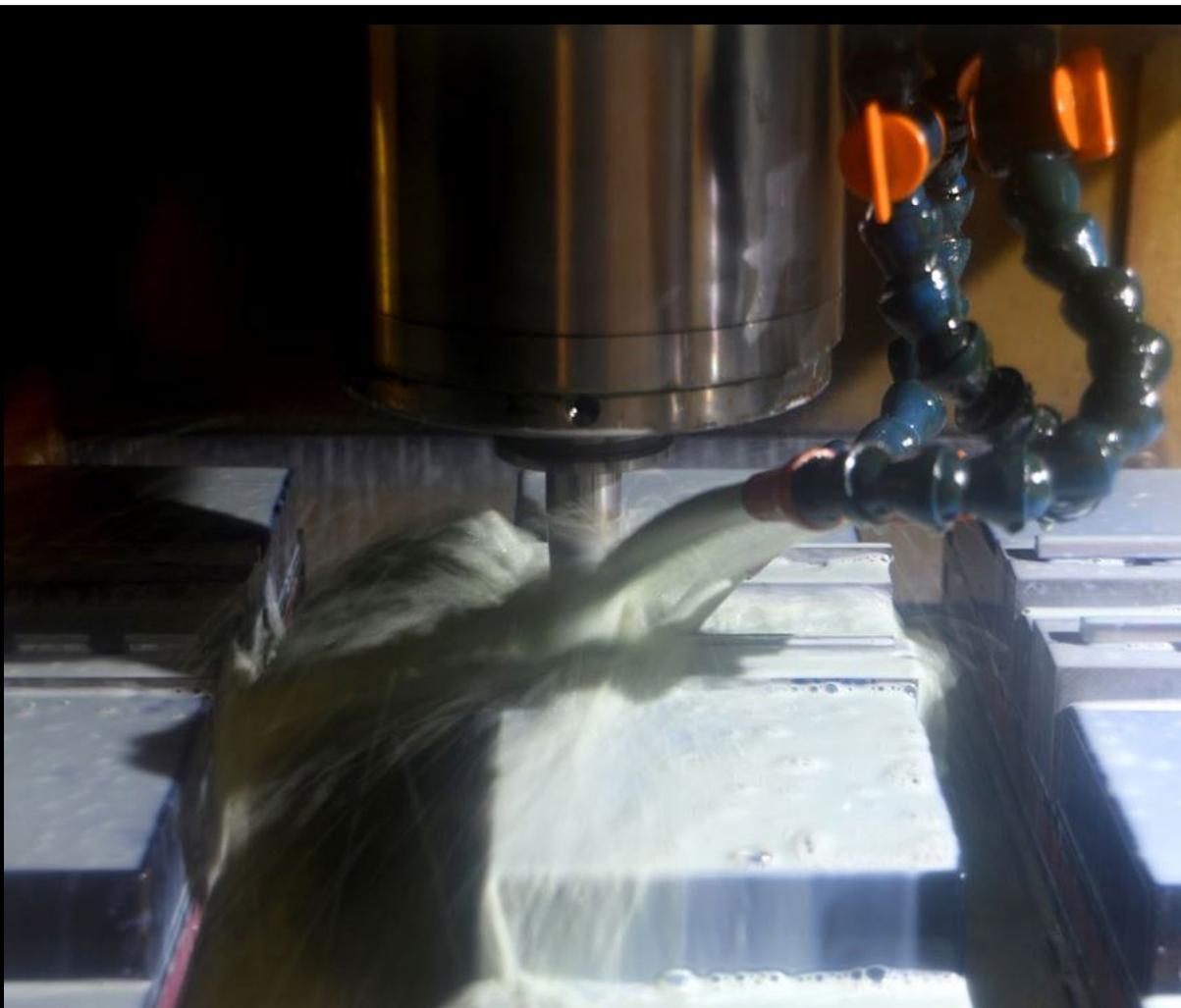


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Gunning for Productivity at the Spindle

Looking to improve its precision milling operations, this firearms component manufacturer went after the vibration problems that were creating poor tolerances and shortening tool life.



JOHN STONEBACK, CEO, JM PERFORMANCE PRODUCTS INC.

The firearms manufacturing industry is a competitive landscape marked with various sized players producing intricate small handguns to large weapons used by the military, law enforcement, hunters, hobbyists, and other specialists. Within this production environment, many complex precision parts and pieces are required for key elements such as frames, barrels, and trigger assemblies—along with a range of other special products including tooling, triggers, safety equipment, fixtures, lower/upper receivers, and others.

Approximately 95 percent of gun parts are manufactured by milling. Large manufacturers such as Smith & Wesson (one of America's longest-standing, leading firearm brands) recognize that tool life is vital to keeping up with production cycle optimization. Therefore, more advanced, rigid machines are being leveraged with the highest grade and exotic materials to overcome associated tool life problems.

One constant challenge to tool life is chatter (vibration), which corresponds to the relative movement between the workpiece and the cutting tool. The condition not only causes poor finishes on the parts but will damage and significantly reduce the life of end mills. Carbide end mills are particularly susceptible to damage. Poor fixturing, workholding, and machine maintenance all contribute to chatter and its associated problems. Chatter in cavity milling also creates uneven wear on cutting tools and shortens tool life, rendering it to be self-sustaining until the problem is corrected.

Recently, Evolution Gun Works Inc. (EGW), Quakertown, Pennsylvania, a designer and manufacturer of parts and accessories for popular rifle and pistol models, had been experiencing significant chatter on its existing machining centers and wanted to eliminate the problem as it expanded and invested in more complex Hyundai WIA mill centers.

Known for its craftsmanship and attention to smithing detail, EGW is one of the largest suppliers of scope mounts, 1911 pistols, and assault rifle parts and accessories in the U.S. Beyond the racket of clunking noises when the tools were loaded and unloaded in their machines, and the high pitch shrills that indicated chatter in the workpiece, EGW principals ultimately wanted to eliminate the potential poor surface finishes on parts (which would require secondary bench operations) and critical damage to expensive workpieces.

To address these issues head-on, EGW's President and founder, George Smith, investigated converting from standard off-the-shelf retention knobs to a specific high-torque retention knob from JM Performance Products Inc (JMPP).

After a demonstration, Mr. Smith believed the theory behind the knobs was solid—resolving improper seating of the toolholder in the spindle that results from toolholder deformation. Essentially, if the toolholder doesn't fit the spindle precisely, a critical “loose-tool” factor occurs that can create the perfect storm for chatter, poor tool/spindle life, and decreased productivity.

Investigations of vibration and chatter issues point to this improper seating of the toolholder in the spindle because when a standard retention knob is tightened, it can produce a bulge in the taper that prevents full contact and correct seating in the spindle. As a result, the toolholder is unable to pull completely into the spindle, and contact is made at the small end of the holder instead of at the large end at the gage line.

JMPP's knob design is longer and reaches deeper into the cross section of the holder's threaded bore. As a result, all thread engagement occurs in a region of the toolholder where the cross-section is thicker to resist deformation. A precision pilot increases rigidity, and the knobs are hard turned to ensure precision fit and are balanced by design with threads cut to start and finish 180 degrees from each other. The high torque knobs will work in existing toolholders.

EGW manufactures gun parts and accessories that must deliver reliable performance under the most stressful conditions and stand up to repeated heavy use. To accomplish this and meet the strict standards of the firearms industry, they use only the highest-grade exotic materials:

- 410, 415, 420, and 17-4 stainless steels
- 4140 and 4340 tool steels
- 7075 & 6061 T6 aircraft-grade aluminum Tungsten guide rods

The firearms industry, like aerospace, medical, and automotive component manufacturing, machines a lot of these exotic alloys and hard metals, which can take a toll on the carbide cutting tools used. The result is that the tools 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 escalate costs as well.

EGW's 23,000-square-foot facility features fourteen CNC mills to deliver the highest possible precision, with tolerances as low as 0.0002. A 4-axis horizontal mill is also used for increased milling capabilities, allowing precision cuts along 4 different axes instead of only 3.

With the solution in hand to address all of these demanding variables, EGW converted all their CNC mill operations to JMPP's retention knobs, including the migration of its new Hyundai WIA machining centers, which are more rigid and capable of simultaneously undertaking multiple processes.

End Result

In firearms manufacturing, the highest quality, precision milled, end-product reliability is vital. By increasing contact of the holder and the spindle at the gage line, a wide range of CNC milling issues were overcome for EGW: vibration and chatter, poor tolerances, non-repeatability, poor finishes, shortened tool life, excessive spindle wear and tear, run-out, and shallow depths of cuts.

EGW's main goal was to avoid chatter and improve surface finishes. The inherent natural frequency of a cutting tool causes chatter. This natural frequency can be affected by many process conditions including cutter tooling, part fixtures, overall machine condition, and most notably, the toolholder.

By addressing the toolholder issue via JMPP's knobs, EGW was able to overcome the resulting chatter that creates surface finish problems and eliminated additional benching operations that add to the cycle times. These issues are true profit-killers because they compromise part quality, create scrap, delay deliveries, and destroy perishable tooling. According to Steve Seaman, EGW's CNC shop foreman, "The knobs are easy to use and we saw the effect instantly. We would run an end mill and have chatter, then change to the JMPP retention knobs with the same lot of material, same coolant, on the same machine, and have no chatter. Impressive! The resulting surfaces are now consistently smooth with no imperfections."

Eliminating chatter also reduces wear on cutting tools and machining centers to minimize machine downtime. This is essential, as tool life is key for firearms manufacturing, where exotic material can present demanding requirements. Notably, military applications are using these less corrosive exotic materials as the discharge's high flash/burn powders don't affect them.

In respect to the issue of chatter across the board, the total system remedy is to eliminate all vibration sources that can lead to harmonic responses. The job should be run on the tightest machine available. The more that the machine's engineering and spindle are tight and robust, the less chatter will occur. Less expansion in the tool holder helps the most on longer tools and runout as well as chatter.

Mr. Smith says, “We’ll be using the high torque retention knobs exclusively moving forward as we order new sets for every new machine that gets delivered. In fact, we are taking delivery of two more machines that will feature JMPP’s knobs.”

JM Performance Products Inc. | 440-357-1234 |

About the Author

John Stoneback is CEO at JM Performance Products Inc., a manufacturer of CNC mill spindle optimization products. The company is dedicated to reshoring, with more than 500 styles of patented retention knobs for BT, DIN, ISO and CAT toolholders from 30 taper to 60 taper, all sourced in the U.S.