CASE STUDY

By Ross Wegryn-Jones

COMPANY: Advent Tool & Manufacturing, Inc.
CUSTOMER: MESCO
A New Tool for Prototype and Production

The following case study describes the development of an involute spline form milling tool for prototype and production applications in standard CNC milling machines.

WELL known for its specialization in indexable and solid carbide thread and form milling tools, Advent Tool and Manufacturing has developed an involute spline form milling tool for prototype and production applications for use in standard CNC milling machines. Utilizing our patented insert locking and locating system on a standard shell threadmilling platform, James Hartford—vice president and general manager—ground a three-tooth form in standard Advent Tool threadmilling insert blanks to accurately duplicate the form required on an end users’ spline shaft form.

“The hurdle on this particular application was twofold,” Hartford says, “getting the tooth geometry planned out per the given workpiece diameter and finding the right application and consumer to prove out our prototypes.”

As it was, Advent Tool distributor Muenz/Engineered Sales Company (MESCO) had the right application. Paul Dunn of MESCO had an end user with an ANSI B92.1-1970 1-1/4” pitch diameter, 30-tooth spline form at 24/48 pitch and 2-3/4” in length. This end user needed to generate an extremely accurate spline form on their stainless steel shaft with a very fine surface finish require-
ment. With the workpiece requirement being of stainless steel, the customer’s options to generate this form were limited, to say the least. “Finding the right manufacturer who could partner with us and our customer on this engineered application was the key,” Dunn says. “Advent Tool was the right kind of company with the right kind of tool designs, and they were willing to put their expertise to work.”

Advent Tool has had vast experience in thread and form milling a variety of forms in stainless steels. We knew that our standard form milling platform was more than adequate for the project at hand. With some development time we completed the inserts, and success was achieved immediately with the end user in terms of cycle time and tool life; not to mention a relatively minimal investment in specialized spline hobbing equipment and tooling.

A typical theme of spline milling applications that we are seeing lately is the need to reduce cycle time and complexity. An application for spline milling was recently quoted and a tool build is in progress for a Tier I automotive supplier that typically took the shaft offline to be hobbed on traditional high speed steel spline hobbing equipment and then brought back to the original CNC milling machine for the final operation. Using the Advent indexable spline milling tool to generate the spline form, and foregoing the offline process, the manufacturer was able to reduce cycle time significantly. Not measured, but certainly implied, were quality and time saving gains by not having to “find” the part again using the aforementioned offline process.

The Advent indexable tool design utilizes completely ground tool bodies and locating devices to hold carbide inserts in an exact position axially and radially. This unique, patented tool design minimizes uneven chip loads amongst the inserts while cutting the workpiece. This precision, in turn, leads to longer tool life, faster speeds and feeds, and more accurate form generation in the workpiece. Coolant through is standard with Advent Tools, with coolant directed between the flutes or right at the cutting tool interface. As you can imagine in an aerospace part, the thread forms must be perfect. Advent’s tool design is known for accurate, repeatable thread generation in the aerospace, commercial, and automotive industries. This spline form application represents the cutting edge of Advent’s form milling pursuits to date.

The application listed here has utilized standard Advent threadmilling bodies, with specialized inserts. Advent Tool has recently had calls for some coarser pitches and larger pitch diameters with finer pitches. In these cases, standard milling bodies were not used, but the same concepts with a special body applied. H13 tool steel was used, and, like their coarse pitch thread milling cousins, bodies were modified and made to suit taller inserts with greater minor/major diameters.

Initial internal tests conducted by Advent to provide proof-of-concept...
in house were performed on H13 tool steel, and the subsequent results were impressive. In a standard CAT 40 class vertical machining center with a fourth-axis rotary table, two passes were needed in each three tooth cutting pass with this eight-flute shell mill tool. The process took a total of 20 passes to complete the part, and 880 surface feet per minute, 1600 rotations per minute, 40 inches per minute feed, and .003” chipload per tooth were the parameters for the roughing pass. 1700SFPM, 3000RPM, 30IPM, and .0015” chipload per tooth were achieved for the finishing pass.

Naturally, this is not going to be competitive with spline rolling in terms of cycle time. However, as it is with most things in life, each choice has its own limitations. Advent tools care not about spline length. Likewise, the form and the surface finish can be more tightly controlled using the Advent system. As long as there are no shoulder interferences (there are options available if this is the case), the milling tools are made to mill workpieces, regardless of workpiece length. Coarse or fine pitches do not matter as much with the Advent system; the inserts are built to suit, and bodies can be made to suit if needed. For that matter, assuming a standard tool body, lead times for new spline milling tools are relatively short—about four weeks from print approval. While other processes have their ins and outs, the typical Advent consumer already knows the parameters of milling.

Threads are just defined forms, as specified by ANSI and ISO, and the appropriate tools are made and kept on the shelf, in stock, at Advent’s headquarters. Coatings are applied to suit the application, but are typically stocked in either uncoated, TiN, or TiAlN varieties. Serrations on (previously) broached parts, front and back chamfers, O-ring/snap ring grooves, and even inserts to generate a defined surface finish on mating pipe flange parts have been successful applications. Advent Tool has also successfully designed and built complete blueprint specials for other forms that customers need as well, such as a one-pitch buttress form.

There have been multitudes of spline milling applications that Advent has completed since MESCO’s original application. Advent inserts are typically ground to suit, but the bodies are almost always standards. What are we working on now? Since completing several spline forms on shafts, the natural progression would be ID spline push broaching. Again, as the design is made specific to the workpiece diameter, Advent does have some initial tool and insert designs that are in the working prototype stage. Pushing three teeth into the workpiece at a time, several strokes are required to generate the full form, but the main advantage has proven to be accuracy, not speed.

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Advent Tool & Manufacturing introduces their indexable carbide involute spline form milling solutions to industry. Utilizing custom ground form inserts and standard, precision ground bodies with a precise insert locking and locating system, Advent can turn hobbing operations into a true milling application! Drop us a line and see what we can do for your application!