EDM SINKER ELECTRODES present one of the most difficult computer numerical control (CNC) programming challenges. The electrodes need to be produced to very high levels of precision in spite of complex geometries. Another problem is that electrodes are produced in small lots, often as small as one, which makes it important to keep programming time short. The EDM Department, a company that provides EDM tooling and contract manufacturing, has overcome these challenges with the aid of new CNC programming software. “The ESPRIT KnowledgeBase™ machining capabilities enable us to embed our machining expertise within the software, which substantially reduces programming time,” said Mark Raleigh, president of the EDM Department, Bartlett, Ill. “We are using knowledge-based machining to develop a storehouse of optimized machining operations that we use over and over again to ensure that each of our programs is as productive as possible.”

While wire EDM uses a wire as the electrode, sinker EDM sinks a required shape into the workpiece. Sinker EDM is particularly useful for machining hard and tough materials with large aspect ratios to high levels of precision. Raleigh began working with sinker EDM in 1978 and started EDM Department in 1997. The company initially focused on consulting work by leveraging Raleigh’s expertise with the relatively unfamiliar process. As the company grew, it discovered that some of its customers preferred to outsource the manufacturing of tooling for sinker EDM or, in some cases, the entire production process. Today, the company’s business is 65 percent production and 35 percent consulting.

ADVANTAGES OF SINKER EDM
“Sinker EDM provides far more flexibility than wire EDM because the electrode can be virtually any shape,” Raleigh said. “One area where sinker EDM has become very popular is producing molds with high aspect ratios. There are many products used in medical and many other applications that have aspect ratios -- the ratio of the length to the diameter of a hole -- greater than 5 to 1. These products are difficult to machine because the tools required to produce them are expensive and fragile. Applications involving high-strength hardened steel used in molding are particularly difficult because the

This 0.0052-inch-diameter, 0.1800-inch-long electrode has an aspect ratio of more than 30:1. ESPRIT’s simulation and KnowledgeBase machining capabilities enabled the company to reduce cycle time on this part.
stress on the cutter is increased. A good example of parts that are typically produced by sinker EDM is the molds used to produce syringes. In many cases, a single sinker EDM mold produces multiple parts in a single operation.”

The EDM Department previously developed CNC programs for producing sinker EDM molds using two-dimensional CNC programming software. One problem with this approach is that a considerable number of trigonometric calculations were usually required to define the part geometry. A weakness of the software was that it was unable to accommodate 3D contoured surfaces. EDM Department programmers were able to produce very simple contours by writing their own G-code and attaching it to the program, but this took so much time that it was only practical for very simple contours. The old software did not support new generation machines, such as mill-turn lathes and four-axis machining centers, so the only way to program them was, again, to write G-code to support advanced machine functions.

INVESTING IN A NEW CNC PROGRAMMING SYSTEM

Raleigh decided to invest in a state-of-the-art solid-model based CNC programming system. “We picked ESPRIT because of its unique KnowledgeBase™ machining capabilities,” Raleigh said. “ESPRIT provides a wide range of features that embed machining and tool expertise into the software. This saves time by automating many tedious programming functions. The knowledge base also can help reduce machining cycle times by providing programmers with standardized operations that have been optimized by highly skilled and experienced programmers.” Over time, the company has created a library of machining operations that handle the vast majority of its programming tasks. Today, when a programmer creates a new CNC program, he can simply drag and drop machining operations from the library rather than creating them from scratch.

As an example of the usefulness of these features, Raleigh explained how he programmed a syringe mold with a finished diameter of 0.0052 inches that had to be maintained to plus two ten-thousands of an inch minus zero. The finished part has an aspect ratio of between 11 and 12 to 1. The electrode was 0.180 inches long, so it required an even higher aspect ratio of over 30 to 1. The company produced this part on a Roku-Roky HC-435 vertical milling machine with a
positioning repeatability of 19 millionths of an inch within its entire machining envelope. In this type of cut, selecting the right machining conditions is critical to success. Simply changing the chipload by a few ten millionths can make the difference between a productive machining operation and a broken cutter. “We have used design of experiments to determine the ideal machining operations for this and other tough cuts found in machining sinker EDM electrodes,” Raleigh said. “ESPRIT gives us the ability to make adjustments in very fine increments, as well as the ability to save machining operations for use on future electrodes.”

Raleigh began programming by opening the SolidWorks solid model of the customer’s part in ESPRIT. Then he examined the part to determine which features were best machined with sinker EDM, which were best suited to wire EDM, and which could be machined. He then divided the SolidWorks model into three separate files, each of which contained all of the features that were to be machined by a specific method. He used ESPRIT’s feature recognition capabilities to analyze each file. The program then automatically integrated the solid model and organized the geometry into features. Raleigh reviewed the features selected by the program and made a few changes.

The next step was assigning metalcutting operations to each of these features. Raleigh and other EDM Department programmers had previously developed machining operations that were optimized for features that are common to the company’s products. “The software automatically applies these operations when it encounters similar features,” Raleigh said. “This ensures that each program takes full advantage of the capabilities of our machine tool and cutting tool. Whenever the company’s programmers define a new machining operation and apply it to the part they are working on, they typically save it in the KnowledgeBase. This saves programming time and cycle time for all future parts that utilize a similar feature.”

The company then uses ESPRIT to simulate the machining operation that has just been programmed. ESPRIT provides a comprehensive and realistic simulation that includes the entire part, tool and machine. ESPRIT enables the programmer to view each individual cut in the entire machining process as dynamic 3D solids. The programmer can also inspect the “finished” part by comparing the as-machined workpiece to the original mold design. By zooming in on the simulated mold, the programmer can determine whether or not it matches the customer’s design. The simulation process provides the ideal opportunity to take a close look at the program that has been created up to that point. Raleigh and other programmers often identify areas where cycle times can be reduced by improving the program.

EDM Department programmers typically nest sections of the program into subprograms to keep files at a manageable size. The subprograms are combined into arrays that typically make 70 electrodes in one night without an operator in attendance. The company also uses ESPRIT to program sinker EDM machines. These programs are relatively simple because the fact that the electrode matches the contour of the finished part reduces the complexity of the machine motion. Programmers incorporate abstract positions along the cutter path, and whenever the tool passes a position it sets a pointer. This means that if the job needs to be stopped it can easily be restarted where it left off to avoid cutting air.

The new programming software and methods have helped EDM Department substantially reduce programming time and increase machining productivity. “We can now program the most complicated parts in considerably less time than was required in the past,” Raleigh said. “The ability to create a realistic simulation of the complete machining operation has nearly eliminated programming errors, which reduces machine setup time. Our ability to optimize machining operations, store them in a library, and quickly apply them to features has reduced cycle time by ensuring the use of optimized machining technologies. ESPRIT also makes it easy to change and evaluate machining operations, which makes it practical to continually improve our programming methods.”

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