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# Software Cuts CNC Programming Time for Dental Implant Maker from Four Days to One

Dental implants represent a complex computerized numerical control (CNC) machining challenge because of their intricacy, close tolerances, and small size. IMTEC Swiss Mfg. Inc. programmers would historically spend three to four days writing G-Code for Marubeni Citizen-Cincom Swiss CNC machines, and another day or two on the machine, troubleshooting the program. The Ardmore, Oklahoma company recently switched to new programming software that uses solid modeling to automate the geometry definition process and allows operations to be moved from one spindle to another by simply dragging them across a computer screen.

“The new software has taken the drudgery out of programming and has cut the time needed to write and set up the typical program to less than one day,” said Marvin Saucer, Manufacturing engineer and CAD/CAM programmer for IMTEC Swiss.

IMTEC Swiss is a wholly owned manufacturing division of IMTEC Corporation, a dental specialty products manufacturer/marketer. IMTEC Corporation designs, develops, manufactures and markets root-form endosseous dental implants, proprietary, pure Polytetrafluorethylene (PTFE) membranes, resorbable membranes and tacks, Sendax MDI mini-dental implants, tissue and bone regeneration systems, surgical drills and instrumentation, and an extensive line of dental prosthetics and laboratory components.



IMTEC's Chairman of the Board of Directors and co-founder, Ronald A. Bulard D.D.S., is a board-certified implantologist who has designed many implant systems including the Hexed-Head dental implant system; the ACCESS curved bristle toothbrush; and the O-Ball concept of the Sendax MDI mini-dental implant system.

## Challenges of machining implants

A typical dental implant has a custom thread form on the outside diameter ranging from 3mm to 5mm diameter, a milled external or internal hexagon on one end, and either a M2 or 0-80 threads on the inside diameter. The custom thread, which resembles a buttress design, is specially designed to engage the implant to the patient's bone without placing undue stress on the surrounding bone. Most of the features of the implant must be held to a tolerance of +/- 0.002 inches. Swiss-turn machines customarily used to produce implants are challenging to program because they have two spindles and nine different types of milling capabilities so that programming a single part actually requires three CNC programs be written to run simultaneously to control the motion of its 13 axis. These programs are linked together by codes that coordinate the motion of the multiple axes.

In the past, the company used manual programming methods, writing variable programs in the G-Code language and modifying them by hand to fit individual parts.

“The parts are so complex that the programs took a long time to write,” Saucer said. “It took at least two days to program a typical part using this method. Then it took another day, at a minimum, to troubleshoot the part on the machine. The biggest challenge was



to synchronize the different operations that were performed at the same time. If we wanted to move operations around in order to improve the efficiency of the program then we had to go back and rewrite the program. The difficulty of coordinating the various spindles and tools meant that we usually had a fairly significant amount of wasted time when either spindle or a turret sat idle while the other continued to work.”

### Switch to new CNC programming software

The company purchased ESPRIT CNC programming software from DP Technology in Camarillo, California via a local Arlington TX distributor, MTTS Inc.

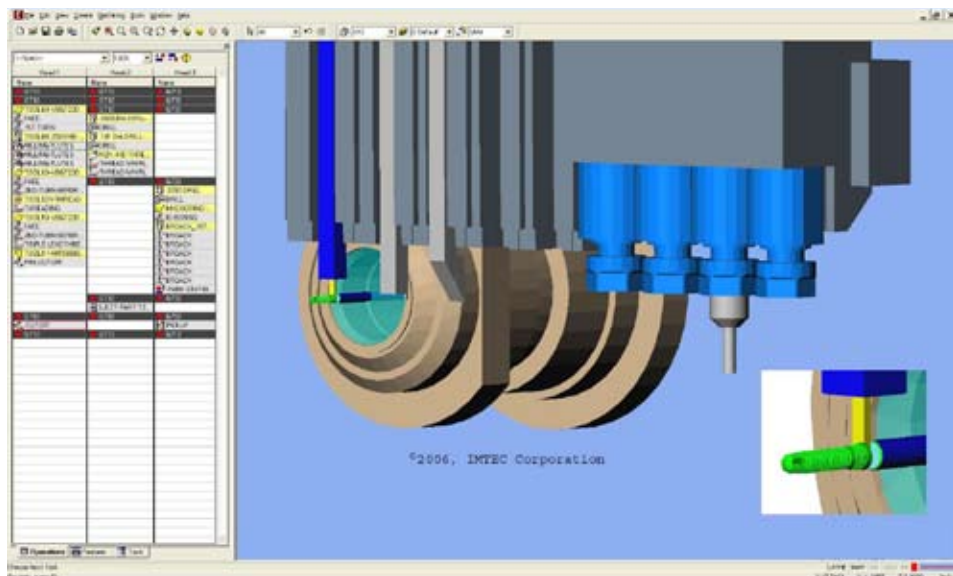
“I met Danny Greer with MTTS in the late eighties and have utilized his company ever since. Danny told me that ESPRIT was the solution for our Swiss-turn programming and so far he has been right,” said Stephen Hadwin, Executive Vice President of IMTEC Corporation. “When I joined the company one of my first objectives was to move to a graphical programming environment,” Saucer said. “What I really like about ESPRIT is that I can take a solid model from SolidWorks, import it into ESPRIT, and I am ready to start applying tool paths to the different features of the part without having to calculate a single coordinate. The support engineers from DP Technology and MTTS provided a considerable amount of help in getting us up and running. Within a month or two, we had substantially reduced our programming time and reduced the time required to troubleshoot programs on the machine tool as well.”

As soon as IMTEC programmers import the part geometry, ESPRIT uses knowledge-based machining methods to automatically

organize the geometry into features that normally correspond to machining operations, such as pockets, islands, bosses and grooves. The software organizes the features into a tree that includes the machining operations needed to produce them. The programmer then reviews the feature tree and in some cases may manually create, modify, or re-order features. Saucer developed a tool library consisting of all the tools used by the company and processes that match a tool with a machining operation, including cutting speed, feed rate, depth of cut, etc. Many of these operations have been optimized to maximize machining productivity. Once the programmer has finished the job of creating and editing the work plan, the software automatically generates code for the machine tool that will be used to produce the part.

### Balancing operations to reduce dead time

The next step is to balance the operations on the various spindles and turrets in order to reduce dead time and maximize productivity. IMTEC programmers typically begin by assigning operations based on their experience and intuition. They add synch points that link operations on different turrets that cause them to be



An ESPRIT screen capture from IMTEC. The ENDURE implant is shown to be parted off from the main spindle. This simulation does not show the sub spindle synchronizing with main spindle.



performed at the same time, then begin a simulation of the machining operation on the computer screen that shows the machine, spindles, and turrets in action. This simulation helps them to identify opportunities for improving productivity and quality. For example, they might switch operations around so that the machine time on the upper and lower turret will balance out in cycle time. Or they might move an operation from one spindle to the other in order to eliminate dead time.

“One of the biggest advantages of ESPRIT is the way it lets us validate the program on a computer screen rather than tying up a much more expensive machine tool,” Saucer said. “Our parts are so small that it’s very difficult to get the cutter compensation right when programming with G-Codes. In some cases where you use a G41 or G42 command the machine controller will generate more line segments than the machine could handle. Or, the programmer might accidentally send a tool with a 0.008-inch tool nose radius into a 0.004-inch radius corner. These types of mistakes can take a considerable amount of expensive machine time to diagnose and correct. With ESPRIT we can find them in the simulation. This helps explain why nearly every part that we program works perfectly the first time we run it on the machine.”

### Reducing programming and setup time

IMTEC can now program an average part in four hours with another few hours setting up the machine with the correct tooling for the new part, running the first part, and then performing a detailed inspection.

“We inspect the part utilizing 3D non-contact measuring systems and then compare the measurements to the solid model engineering drawing that expresses the design intent,” Saucer said. “This is necessary because our average tolerance is +/- 0.001 inch. We rarely find a problem with the first part because importing the solid model into the software ensures our geometry is correct and we catch any tooling mistakes when we run the simulation.”

Working with the DP Technology support representative, IMTEC has also taken advantage of ESPRIT’s Visual Basic (VB) programming interface to develop macros that automate the process of programming inside diameter broaching operations.

“This is a very challenging operation to program because the tolerance of our ID broaching operations is typically +/- 0.0005 inches,” Saucer said. “The program simplifies the job by asking the programmer for the inside diameter, the number of flats to be machined, if the ID is tapered, the size of the broach, and whether a



Ron Floyd, Production Manager (bottom center), shown with the Weekend Shift #1 CNC department.



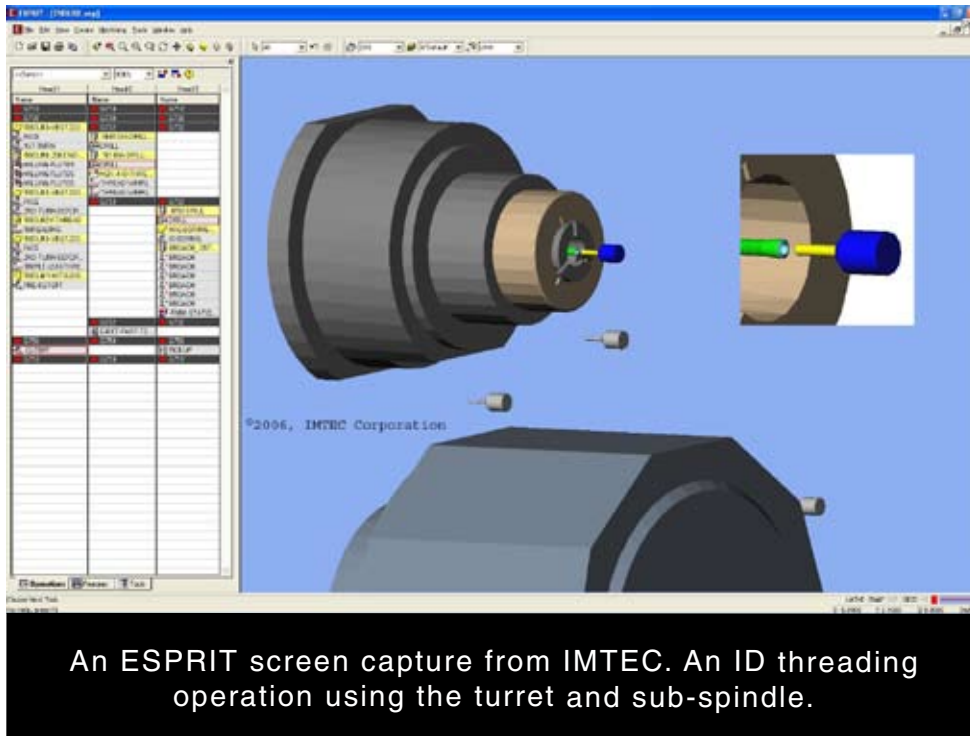
Marvin Saucer, CAD/CAM Engineer, is performing CNC program verification at the machine.



six-sided or one sided broach will be used. The macro then generates the code needed for the broaching operation. Broaching operations prior to the VB macro would take about 30 minutes to program by hand with G-Codes. With the ESPRIT macro it only takes a minute or two.”

“The implant business has changed considerably in the last few years,” Hadwin concluded. “Our company has stayed ahead of our competitors by developing

innovative implant designs that are more effective and durable. The challenge is that these new shapes are more complicated and difficult to manufacture. Our switch to new CNC software has helped us quickly develop programs that consistently produce products with very high levels of quality.”



An ESPRIT screen capture from IMTEC. An ID threading operation using the turret and sub-spindle.

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