

White Paper

Tool Shop Optimization:
Stepping Up to 5-Axis

Prepared by Cimatron Technologies, Inc.

5-Axis: A Weapon to Battle the Competition

5-axis technology is used in a variety of applications, including the production of impellers and turbine blades, cutting tools, ports and inlets, as well as the machining of aerospace structural parts, rubber molds, patterns and models, medical implants, and deep cavity molds.

Although 5-axis technology has been in use since the 1980's, several market trends are driving an increasing number of manufacturers to step up and adopt the technology these days.

The demand for 5-axis technology is fueled by increasing global competition in virtually all sectors of manufacturing, competition that forces manufacturers to seek new ways to improve product quality, cut costs, and reduce delivery times.

5-axis technology enables manufacturers to gain a competitive advantage on all of these fronts. At the same time, 5-axis technology has matured to the point where it is better understood, easier to use, more reliable, and more affordable to manufacturers of all sizes.

With 5-axis machining, the part can be rotated and positioned around the tool (or multiple tools), instead of multiple tool setups required to access the part in conventional 2-axis and 3-axis operations. As a result, it helps deliver high quality products by providing better positional accuracies, especially for multi-sided operations. It also enables the use of smarter and shorter tools that improve accuracy and surface quality, therefore eliminating the need for polishing and minimizing the need for electrode burning while at the same time increasing tool lifetime.

5-axis enables the production of complex parts as a single process, reducing the time and cost of production by minimizing tool changes and setup requirements. With a single machine setup, manufacturers are able to increase the use of automated and unattended production runs, increasing machine utilization and reducing labor cost.

5-Axis Software Solution Requirement

While adopting a 5-axis technology can translate into extensive business opportunities and operational advantages, stepping up to 5-axis carries its own set of challenges. Your designers, programmers and operators may have limited experience with this technology, and will be facing a learning curve while getting up to speed on the different machining strategies required for different parts.

The key to successful transitioning to 5-axis is to have the right combination of machines, tools, software, process, and training. To help you get started, following are the requirements you should look for in a software solution to support your 5-axis operations.

1. Multi-axis machining with no limits to geometry and part type

Your 5-axis investment will be considerable. To recoup this investment, it is important to have the utmost flexibility with software that enables the machining of a variety of parts rather than limit you to a particular application. Look for software that supports multi-axis machining with no limit to geometry and part type, including 3-axis, 4/5-axis continuous, and 3X+2 positioning, as well as the ability to handle a variety of cutter types and shapes (e.g. T-slot, lollypop).

2. Powerful toolpath generation

To take advantage of the efficiencies and automation offered by 5-axis machining, your software must be able to generate a 5-axis toolpath that can be absolutely trusted, especially if you plan on running production unattended. To ensure that your toolpath is efficient and safe, your software should support multi-level gouge control, material removal, and machine simulation.

3. Wide range of post processors

The post processor offered by your vendor is critical to your ability to run a smooth 5-axis production. It is also an important indication of how knowledgeable your vendor is in 5-axis and how well they can support you in this transition. Ensure you have investigated this aspect with the vendor prior to purchasing a 5-axis software solution.

4. Automation without sacrificing user control

The software should be easy to use and offer a high degree of automation to streamline programming and help users get up to speed in minimum time. At the same time, as users get more comfortable with the software, they should have the freedom to manually control every option. To address complex machining conditions, it is important that the user has complete control over tool orientation. To enable this level of control, make sure that your 5-axis software has powerful solid and surface modeling capabilities.

5. Facilitate the entire process

You don't want to force your users to keep jumping back and forth between applications. Your 5-axis software should enable users to perform a complete process from A to Z, with CAD/CAM integration to help streamline the process and eliminate data transfer associated with toolpath regeneration.

6. Expert support

Last but not least, you want to ensure that your software is supported by industry experts who understand 5-axis technology. The vendor should have the flexibility to train your users either on-site or remotely. Prior to the training, it is recommended that your post processor is installed and ready to work. Another area to investigate is to be sure your supplier provides remote support capabilities and user access to a knowledge base.

Implementation Considerations

Once you have selected the right 5-axis software, you need an implementation plan to ensure the software is well integrated into your production processes and that all users are on-board and capable of using the new technology.

The following is a recommended best practices implementation checklist based on real-life experience.

- Goals and Processes**
 - Define the business goals for 5-axis implementation
 - Define engineering and shop floor processes
- Shop Floor Preparation**
 - Post processor(s) implemented
 - Run machine simulation
 - Cut calibration part
- Training**
 - Relevant modules (expect: CAD, Surfacing & NC)
 - Friendly tutorials, on-line help
 - Case study library
 - Advanced training
 - Make your first production project part of the training
- Support**
 - Experts available on-line
 - Remote support capabilities

Case Study: Regal Prototype

Regal Prototypes, Inc. is located in Sterling Heights, Michigan and owned by the Schaller Group. The Company has been a tooling supplier for over six decades, specializing in sheet metal stampings, production tool & die, and assembly/welding.

The sheet metal manufacturing plant serves the big three automotive manufacturers, as well as a number of aerospace and marine customers. Regal provides these customers with solutions ranging from prototypes through production tool tryouts and short-run production.

In order to deliver the highest quality product, Regal never hesitates to invest in the latest technology. As Steve Hamrick, Tooling Manager at Regal's sheet metal facility, notes, "The Company is always ready to step up and invest in the technology we need to get the job done. This is one of the reasons I have been working here for over ten years. I know that the best machines and software are going to be made available to do the best job."

Challenge: Developing a New Product for a New Market

Given the recent challenges faced by the local automotive industry, Regal was looking to diversify its business and enter new markets. Since the Schaller family has been involved in boat racing for over 40 years, they recognized an opportunity to step into a new market in producing racing boat propellers.

At the beginning of 2006, they decided to initiate this new venture. To build the propellers effectively and to the standards Regal is accustomed to delivering, they realized they would have to utilize 5-axis production and quickly acquire the technology and the knowledge to master this process, as Hamrick explains: "To get a true concentric blade, we needed to move to 5-axis which requires just a single setup, compared to multiple setups of 3-axis."

Solution: CimatronE NC 5-Axis

To build racing propellers, Regal needed 5-axis capabilities that enable accurate production of complex propeller shapes with high efficiency and short delivery times.

Regal went on to evaluate a number of software solutions to support the transition to 5-axis. "We asked the vendors to demonstrate their capabilities using our part (a propeller) which we gave them at the time of the demo. Cimatron met the challenge very effectively by creating the required toolpath from our data during the demo. The other vendors failed to complete this task. It was clear to us that Cimatron could create efficient toolpaths in real time."

Once the Cimatron 5-Axis software was installed, Hamrick began the learning process which was vital to moving forward with the project. He notes, "With one setup machine such as 5-Axis, the difficulty is making sure that you are set up right, your origins are there, and your safety clings are at the right spot. I never had a problem seeing 3D, so walking around this propeller was not an issue for me, but working from that one single (model) origin was a new thing I had to learn. It took me about 2 weeks to get used to it. After I got the process down and understood the way the post and software works, I was ready to move forward."

The next level included learning a new style of cutting. Hamrick says, "I couldn't go in with my usual style of cutting, but had to learn what the software was going to do first and then convert based on what the software required. CimatronE NC 5-Axis offered a whole new gamut of options, enabling me to ultimately choose the best style for my work. The Cimatron software facilitated a manageable learning process that helped me meet my timeline."

"Another aspect of the transition to 5-axis was getting the post processor to work properly right from the get go. We heard from other toolmakers about the difficulties of developing 5-axis post processors. With Cimatron, the post processor has worked right from the first time we used the software and was very easy to learn."

Hamrick immediately began to see the benefits of working with the Cimatron 5-Axis software. For example, the simulation option has helped with collision avoidance. As Hamrick points out, "We run the program through the Cimatron Verifier and we can see if the holder or the spindle will get hit. Working with tight tolerances, there are times when the holder looks like it is going to hit, but using the Verifier confirms it is not going to. The Verifier double checks everything before I send a program out."

Regal is making good use of the library of machining strategies offered with the Cimatron 5-Axis package. Hamrick says, "Our machine holds 32 tools and they all have been programmed into the library."

Results: New Prototype, New Market, High Demand

The Cimatron solution enabled Regal to get up-to-speed quickly on 5-axis production. In addition, Cimatron has provided a high level of customer support to get Regal up and running. Hamrick says, "Cimatron has been very helpful, holding our hands and offering some procedures for us to follow. I have been able to use their examples and apply them to my application."

The decision to follow a family passion and embark on a new market has proven more than satisfactory for Regal. There is a high demand for the

racing boat propeller, and in just three months the NC experts are ready to go with 5-Axis. Using CimatronE NC 5-Axis has helped Regal launch into a new market with a new product both cost-effectively and quickly. Hamrick says, "Things are going so well that we are looking at bringing another 5-Axis machine on board to fill the demand for the propellers. Other people at Regal are watching and learning the Cimatron package to see how it works. Most likely within a year there will be two more people running with this software and we will be producing even more prototypes."

For more information, visit www.cimatrontech.com.