



## 5-Axis Machining Technical Article

By Patrick Reynolds & Keith Felts

Technology has played a major role in the modernization of manufacturing, and 5-axis machining is no exception. The digital computer allowed for the introduction of numerical control machines in the 1940s and 1950s, revolutionizing machining processes. Then, it didn't take long for the invention of 5-axis machining to come along in 1958.<sup>1</sup>

Five-axis machining allows manufacturers to create sophisticated, curvy metal components required for a variety of applications in aerospace, space, medical and power generation markets. The blades of the jet engine shown in the picture on the right were manufactured via 5-axis machining, as were the internal rotor blades of the steam turbine shown in the picture below.

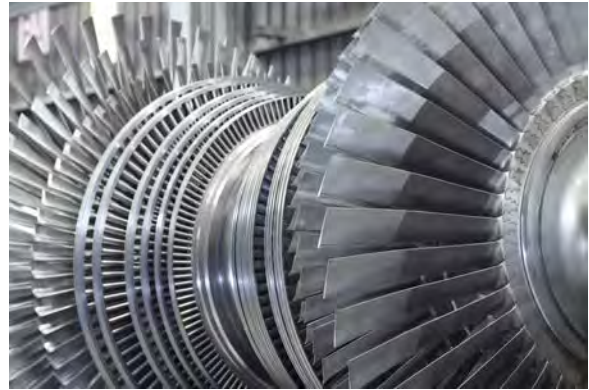


In 2020, 5-axis machining has become an intricate part of the success at Advanced Machining & Tooling, a Compass Precision operating company.

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<sup>1</sup> "Let's Talk About 5-Axis Machining," COMPLETE Solutions, Inc. July, 9, 2020, <https://complete.com/5-axis-machining/>.

True 5-axis machining involves moving the part or the cutting tool along five different axes simultaneously. The most commonly used axes in CNC machining are the linear X, Y & Z-axes, but while 5-axis machining moves the tool back and forth (x-axis), in and out (y-axis), and up and down (z-axis), it can also rotate the part or tool at the same time. This results in the tool cutting along two additional axes -- any combination of the A, B & C axes.



The most obvious advantage to this type of machining is its efficiency. 5-axis machining is also often referred to as “done-in-one” because it can be performed in a single setup. Without needing to stop the machine and manually shift the workpiece, lead times and costs are reduced often by more than half. Accuracy also increases because with fewer setups, the possibility of human error drops.

A great analogy for the difference between 3-axis and 5-axis machining is a standard computer printer versus a deluxe printer that can automatically print on both sides of paper. The standard printing process requires more human involvement because it doesn't automatically rotate the paper for dual-side printing. The standard printing process is slower and more receptive to human mistakes.

But there are plenty of other advantages to 5-axis machining. The process uses shorter cutting tools, which means the spindle speed of the machine is higher and cutting time is faster. Shorter cutting tools often result in better surface finishes as well.

Furthermore, 5-axis machining allows for every surface except the clamping area and the bottom to be machined. It also provides factories greater flexibility for part design. 5-axis machining can create intricate shapes and contours that simply aren't available through other CNC processes.

The abstract scene shown in the photo to the right depicts a 5-axis CNC machine cutting an aerospace turbine part. The starting material and finished component are superimposed in the background. This part would be very difficult or impossible to machine with only three axes, and the tolerances required render other manufacturing processes impractical.



But while 5-axis machining continues to grow by more than six percent each year<sup>2</sup>, many American manufacturing companies aren't fully taking advantage of all the opportunities a 5-axis machine can provide. Instead, some manufacturers are using machines designed for "done-in-one" only for 3-axis machining. 5-axis machines are complex and more difficult to operate while

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<sup>2</sup> "Let's Talk About 5-Axis Machining."

other companies find the process too expensive to invest in over the short term.

Advanced Machining doesn't possess these common weaknesses but instead employs numerous modernized techniques in the CNC industry. President Keith Felts and his staff fully embrace the newest technology available and perform 5-axis machining using incredibly advanced CAD and CAM software. This makes the "done-in-one" process as seamless as possible. In total, the company owns three Mikron machines that can operate on 5 axes.

Using 5-axis machining, the Compass Precision operating company creates a lot of truly unique parts in rare shapes that wouldn't be possible to machine with other processes. Additionally, due to shorter lead times and higher throughput, Advanced Machining is able to respond more fully to ever-changing needs. The customer benefits with quicker deliveries and part geometries that exactly meet the needs of the application.

Advanced Machining has mastered the art form of 5-axis machining, using the process to fulfill shipments in the aerospace, medical, military and power generation industries.



## About the Authors



### Patrick Reynolds

Patrick is Advanced Machining's Operations Manager. He has a diverse background in various machining technologies, including horizontal and vertical milling as well as wire and sinker EDM. He previously worked at several other machine shops in positions of increasing responsibility before starting at Advanced in 2015.



### Keith Felts

Keith co-founded Advanced Machining in 1985 and has served as President since then. He is a leading expert in electrical discharge machining, particularly sinker EDM. He previously worked as an application engineer for Agie Charmilles, a top manufacturer of EDM equipment based in Switzerland.