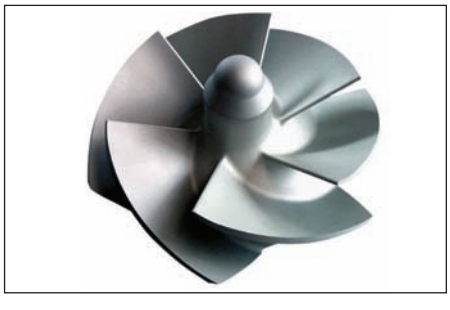
ADVANCED TURBOMACHINERY BLADE MILLING

EFFICIENCY GAINS CAN BE TRACED TO THE COMPETITIVE COST OF MACHINED PARTS



Advanced machining methods have opened possibilities unthought of a few years ago. The tiny fuel pump shown at left or the shrouded parts shown at the bottom right are good examples: the precision and complexity are state-of-the-art.

Indeed, many efficiency gains of the past several decades can be traced to the competitive cost of machined parts now common in many applications. Low cutting time plus good surface finishes, coupled with increasingly friendly software to set up the cutting process have led to ever-increasing use of 5-axis Computer Numerical Control (CNC) machined parts. The wide availability of fast CNC mills and excellent tooling is also part of the process.

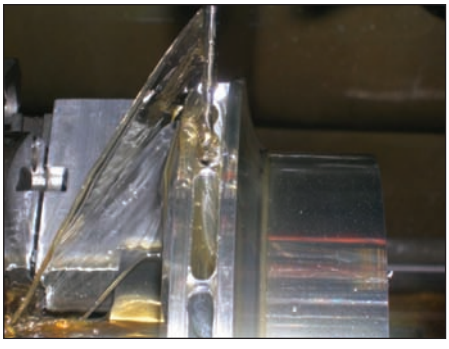
Technique, too, is critical for effective machining. Today thin blades are commonly made (the blade in the first illustration is only 0.007”/0.18mm thick at the shroud line) leading to performance gains; but this requires good tool control with carefully managed blade contact stress; expert machinists know how to manage this issue.

CAM (Computer-Aided Manufacturing) software has helped to bring the once exotic process of 5-axis blade milling to the mainstream. Programming time has gone from weeks to hours. In a product development scenario, the blade shape can be modified, and new toolpaths can be ready in moments. In this mode, machining effectively becomes a rapid prototyping process.

CAM systems have also brought increases in efficiency and quality. New strategies are available for fast metal removal, taking advantage of new cutting tools and high-speed milling machines. Ruled surface blades can be flank-milled in one pass (see U.S. Patent 5391024). Collision avoidance algorithms allow larger, stiffer tools to be used, often allowing production of parts previously thought unmachinable.

Advances on the hardware side have also benefited blade milling. For example, 5-axis machines are faster than ever, some with linear motors (instead of gears) in all axes. The latest machine designs are rigid while allowing extended axis range to approach parts from all sides. The computer controls that drive the machines are more powerful and have new features that optimize speed, accuracy, and smoothness of the cutting motion. Cutting tools have also seen improvements, with new tooth geometries, materials, and coatings.

The technology for blade milling continues to advance. Challenges today include ever-increasing cutting speeds, and controlling force levels and vibration on the tool and resultant blade. Also, new strategies are constantly evolving to optimize the cutting process and leverage the capability of new cutting tools and milling machines. TI



Author

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