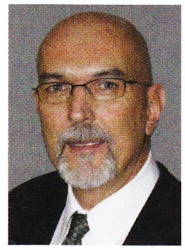
Aircraft Engine Materials Drive

New Machining Technology Development



Thomas Dolan
Vice President
Mitsui Seiki USA Inc.
Franklin Lakes, NJ

Aerospace manufacturers are specifying high-temperature materials that increase engine performance, boost thrust, improve fuel efficiency, reduce noise, and meet safety standard—all while lowering manufacturing costs. To address these demands, engine designers are turning to materials that are harder, stronger, tougher, stiffer, more resistant to corrosion or oxidation, and exhibit a higher strength-to-weight ratio. As such, advanced composites and high-performance superalloys are playing an important role in the latest generation of jetliner engines.

The trouble is, many of these materials are impossible to machine by conventional methods. Only 3–7% of the new materials being used can be processed with standard CNC machining centers. What's more, the top tier suppliers need to gear up quickly as the OEMs are, and will continue to be, outsourcing much of the manufacturing of these critical engine components.

The volume of new engine component production is increasing rapidly. Boeing's goal is to produce up to 46 jets in the 737 class each month. Its 787 program is building up to as many as 10 per month by 2016. Airbus has similar plans. Bombardier, Mitsubishi, and others have new aircraft models on the way as well. Pratt & Whitney, GE, Safran, Rolls-Royce, and Honeywell have new engine programs underway or are modifying existing designs. Military aircraft engine requirements are similar and are also expanding in volume.

While there are common threads among all the engine manufacturers in the types of materials now being used, there is a significant difference in approaches being taken to machine them. The proprietary knowledge regarding the exact material composition and the ways to manufacture it have become a key competitive differentiator among the engine builders. Mitsui Seiki has been partnering with two major engine builders over the past six years, developing new machine tools to process several of the high-temperature, high-nickel alloy components that are being processed today.

The trouble is, many new materials **are impossible to machine by conventional methods**.

This new equipment technology has spurred the development of alternative methods of machining. One of the new processes we have helped implement is akin to superabrasive machining. Another is an electrolytic metal removal process. We will be delivering the first series of these new types of production machines this year for critical rotating parts such as blisks and impellers. We have also recently installed special machines for processing the tips and roots of intake fan blades that are made of a hybrid of carbon fiber with titanium leading and trailing edges.

The parts in the engine that surround the rotating parts such as engine cases, combustion chambers, and combustor liners also need to be made of new materials that are lighter and more heat resistant than previously. Some manufacturers are switching to carbon fiber composites for engine cases, advanced titanium grades for compressor housings, and thermal resistant materials such as ceramics for combustion chambers and liners.

Another major shift in engine designs for fuel efficiency relates to the airflow around the major components. It's common for some workpieces, primarily jet engine high-temperature alloy parts, to require thousands of small diameter airflow holes—each at a different angle—to be drilled in a noncontact manner. The previous ways to drill these holes were relatively inexpensive and simple, such as with conventional drilling machines, EDMs, and laser drilling. However, the complexity of these holes has grown into more intricate patterns for optimum engine performance, and the sheer number required is astounding. Therefore a need for very high-speed, extremely accurate laser drilling is emerging. Working with a major engine maker, Mitsui Seiki created a high-speed, ultraprecise laser drilling machine that has been in production for almost two years.

It is an exciting time in aerospace—one of the few expanding markets in our economy. The enthusiasm is tempered, though, by a very real concern: Aerospace OEMs tell us the manufacturing supply chain is not prepared to accommodate the volume of work needed to be done now, and there's much more to come. Generally, subcontractors have not made the necessary investment in the new technology required to machine the new materials. Current suppliers to aerospace as well as those who want to learn more about the market's new requirements and position their companies to serve it, would be well advised to consult with the experts.