Manufacturing processes

Compressors and turbines made by MTU are among the finest to be found in the marketplace. Another field in which the company, which has been providing propulsion systems to power aircraft for decades, has become a world leader is manufacturing techniques. In some manufacturing technology areas, MTU is the undisputed Number One in the world.

The most important high-tech processes used by MTU:

- **Lasercaving**
- **Adaptive milling**
- **Precise Electrochemical Machining**
- **Friction welding**
- **Additive manufacturing**

**Lasercaving**

MTU's engine specialists have developed the lasercaving technique and hold a global patent on this method of manufacturing, which combines two separate processes – laser drilling and laser ablation – and is a key technology when it comes to boosting turbine efficiency further. It uses a laser to generate flared cooling air holes in high-pressure turbine blades and vanes. Through such holes, the outflowing air spreads more advantageously over the component surface. As a result, less cooling air is required and efficiency is improved.

On the GP7000, which powers the Airbus A380 mega-liner, high-pressure turbine efficiency is increased by one percent, with a resulting reduction in fuel burn and in CO₂ emissions in the same order of magnitude of one percent.
Blisk manufacture

Blisks (blade integrated disks) are high-tech components manufactured in one piece that eliminate the need to fix separately manufactured blades to the disk. This increases strength and reduces weight. Blisks are used in low-pressure and high-pressure compressors for military and commercial applications. Potential applications in the turbine are under discussion. MTU is one of the leading manufacturers of these blade integrated disks (blisks) worldwide. In addition to adaptive milling, the production processes used in blisk production include PECM and friction welding.

4,000 units Number of blisks produced annually by MTU from 2016.

MTU has built a new shop on its premises in Munich, which houses its center of excellence for blisk production.

“Electrochemical machining is a standard technique that has long been part of our portfolio of manufacturing capabilities. PECM allows us to work even more precisely and effectively, as only two steps are needed to produce a nickel blisk airfoil.”
Richard Maier, Senior Vice President, Production Development and Support at MTU Aero Engines in Munich

The principle behind PECM:
Here is how PECM basically works: Material is removed electrolytically, that is in an electrolyte under the action of electric current, in a controlled manner from a metallic workpiece. In the process, the material to be machined is the positive pole and the three-dimensional metallic forming tool is the negative pole. The electrolyte used is an aqueous sodium nitrate solution, which flows between the anode and the cathode. The liquid has three main functions: It carries the electric current between the tool and workpiece, it removes the dissolved materials and the hydrogen formed in the process from the machining area, and it dissipates the heat produced. The advantages it affords over conventional machining: The tools do not actually touch the workpiece, so they do not suffer wear in the process. Moreover, PECM allows an unprecedented level of precision to be achieved, not least thanks to the extremely narrow machining gaps of just a few micrometers.

Large titanium blisk airfoils are fitted to the disk one by one by linear friction welding and then finish-machined by adaptive milling. Medium-sized and small titanium blisk airfoils are milled from the solid. Small and medium-sized airfoils made from nickel-base alloys – that is, from materials that are difficult to machine – can alternatively also be produced by PECM. As is generally the case with electrochemical material removal processes, no finishing of the machined surface is required. The PECM method used is an in-house development.

Blisk manufacturing for the PW1000G program
Tandem blisks and compressor spools – several successive compressor stages arranged in line – are produced by rotary friction welding. MTU's shop in Munich boasts one of the world's largest and most precise rotary friction welding machines. The equipment, which is about 20 meters in length, is a double-spindle configuration that permits a wide range of components to be welded with an ultra-high degree of accuracy. When friction welding compressor spools, a pressure of 1,000 metric tons is applied.

View into MTU’s friction welding machine at the company’s Munich location

For MTU, friction welding is a key technology needed for the production of rotors for next-generation engines that are made from higher-strength materials and are markedly larger in size than conventional components. The technique lends itself to the manufacture of more compact, highly integrated compressor rotors made from titanium and nickel-base materials whose reduced weight helps cut down on fuel consumption. Another process in MTU’s portfolio is inductive high-frequency pressure welding, which is used to fit mid-sized titanium blades to disks.
Additive manufacturing processes

Additive manufacturing technology is rapidly spreading from one industry sector to the next. In the field of aero engine construction, Munich-based MTU Aero Engines has achieved a breakthrough: As one of the first companies to use the new technique, MTU produces components for production engines. These parts - borescope bosses for the PW1100G-JM engine, the Pratt & Whitney engine to power the A320neo – are made by selective laser melting, or SLM. These components are part of the turbine casing and allow the blading to be inspected for potential wear.

“We are pressing on with additive manufacturing in technology projects and technology programs, giving its development top priority.”
Richard Maier, Senior Vice President, Production Development and Support at MTU Aero Engines in Munich

The aim is to explore new designs, new components – conceivably airfoils for compressors and turbines, as well as housings – and new materials. As part of Clean Sky, the most ambitious technology initiative ever launched in Europe, MTU is currently manufacturing a seal carrier using additive processes. The inner ring with integral honeycombs will be installed in the high-pressure compressor and contribute to a weight reduction, lighter-weight designs being one of the key objectives in engine and aircraft construction.

Contact: Martina Vollmuth, martina.vollmuth@mtu.de, +49 (0) 176 100 17133