

# Building the Technology and Production Lines to Precisely Mass-Produce Blades with Complex Shapes

## —A Key Person in Electrical Machining—

In order to improve jet engine efficiency, a large number of complexly shaped blades are indispensable. This article spotlights a key person who is very familiar with a broad range of electrical machining technologies used to efficiently and precisely machine these blades, and who oversees the building of production lines and the development of processing technologies.

### **Soma: the production base of blades, a crucial component of jet engines**

About 20 minutes away by taxi from Soma Station on the Japan Railway Joban Line, the IHI Soma facility sits nestled among a rural landscape of gently rolling fields. Completed in 1998, the Soma facility is the fourth production base of IHI's Aero-Engine & Space Operations, carrying out integrated production from materials to component processing, with a primary focus on turbine blades for jet engines. The Soma No. 1 Works primarily manufactures jet engine blades, but also handles rocket engine parts and gas turbine blades. The low-pressure jet engine turbines primarily fabricated by IHI consist of multiple stages. In each stage, approximately 100 to 150 blades are used, and currently the Soma No. 1 Works produces a yearly output of approximately 800 000 blades (with a goal of reaching 1 000 000 blades per year).

Takashi Furukawa builds and manages production lines for blade processing in which blades are electrically machined rather than shaved with cutting tools. Furukawa is also involved in the development of new technologies, such as the new metal cladding technology (MS Coating) that implements electrical discharge machining.

“The interesting thing about electrical machining is the way you can innovate to achieve machining that is not possible with other methods. Electrical machining encompasses techniques such as electrical discharge machining, beam machining, and laser machining, but these machining technologies themselves are also evolving, so we experiment with these various methods to create finished parts with complex shapes. One time IHI was making a component with a complicated groove, but the shape of this groove wasn't possible with milling techniques using a cutting tool,

so the electrical machining team was brought in. When we tried electrical machining, the job went smoothly. When I am given a new challenge, I never want to have to say that it's not possible. The satisfaction of being an engineer is in finding innovations to overcome challenges and achieve something.”

### **Electrical machining: processing materials without cutting, polishing, or grinding**

Among electrical machining techniques, electric discharge machining is a technology that machines the surface of a material by successively producing small sparks that are electrically controlled. The diffuser holes arranged on the surface of high-pressure turbine blades are created with this machining technology. Diffuser holes are tiny holes about the size of a pinhole that allow the passage of air to protect



Component made with electrical discharge machining



MS Coating processing line

blades from heat while the engine is running. The pinhole diameter is not the same at the entrance and exit, but is a conical shape that widens toward the exit. Since the creation of such holes is not feasible with a rotary drill, electrical discharge machining is used.

MS Coating is a new technology that was derived from electrical discharge machining, with Furukawa's involvement. MS Coating is a type of build-up welding that differs from electric discharge machining. This technique originated from the need to incorporate an automated welding technology for forming a hard anti-wear coating on the contact surfaces of neighboring blades into the production line when the Soma facility was established. However, welding requires the delicate touch of the human hand that is difficult to reproduce with machinery. Additionally, welding requires pre- and post-bench work, and common sense dictated that it was not suited to line production. However, the use of electrical discharge machining demonstrated that by using a slightly sintered metal, it is possible to consistently form a hard functional coating on a metal surface using electrical discharge energy. Developing and applying this technology led to its automation, and successful incorporation into a production line instead of hand welding.

Furukawa explains, "Right now, we've started using MS Coating for the contact surfaces of nickel alloy blades. However, blade materials are currently transitioning from nickel alloy to materials that are more difficult to weld, such as titanium aluminide. So I think that the MS Coating is going to find a wider range of application."

### Parts processing is supported by efficient production lines and fixtures

Furukawa joined IHI in 1994 at the Tanashi factory, but soon after participated in the Soma Works startup project. One characteristic of the Soma facility is that unlike factories that aim for mass production with large, general-purpose machines, Soma took the path of raising production efficiency to mass-produce products by downsizing as many machine

tools as possible, and using compact production lines to manufacture products in a one-piece flow production line. In a one-piece flow line, parts are always moving without getting backed up, and there are few reductions in operating efficiency due to trouble with large equipment. Utilizing his broad experience with electrical machining technology, Furukawa has been involved in constructing this production line from the beginning, and is currently also responsible for improving, maintaining, and managing the line. The speedy recovery in the wake of the Tohoku earthquake and tsunami provided proof of the soundness of the basic principles behind this production line.

"They say that parts processing is the star of manufacturing, but you can't ensure the precision of the parts being processed without the solid foundation of good machine tools, fixtures, and flow line. Through my involvement in production engineering, I feel that many of the most important aspects are in what you don't see."

Fixtures are the holders and receptacles able to firmly and reliably hold a part in place, even when a force is applied to it during processing. Secure fixtures prevent discrepancies in the final result caused by the idiosyncrasies of individual engineers, such as posture or stance.

"The key to manufacturing precise components is in creating fixtures matched to the machine tool and processing method. One good fixture will help ensure the quality of a large number of blades."

Modern aircraft materials are in transition as they evolve into lighter alloys and even to non-metallic components at an accelerated pace. Processing new components according to new methods, and mass-producing parts efficiently and at low cost with high precision are urgent tasks. For Furukawa and other key persons in respective processing technology fields, the ability to manage and coordinate efforts is an indispensable part of improving the factory's overall technical skill.

"Starting up the new facility is my greatest pride. It may be that chance and timing are important for any job. I feel that I am here now as a result of doing my best at each opportunity," says a humble Furukawa, with an unforgettable warm smile.



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