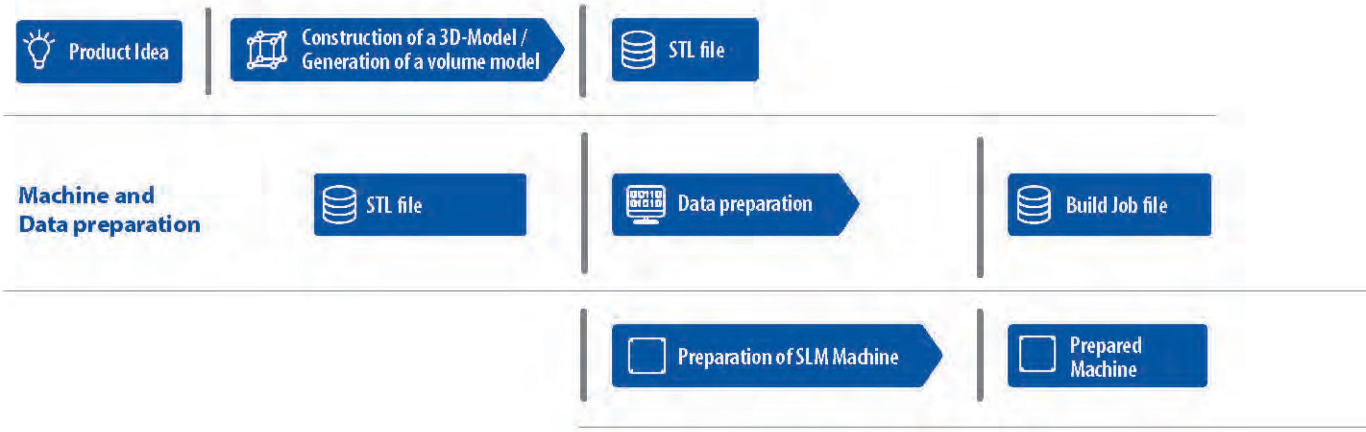
Case Report
Description of the process chain using the example of a swirler

Stationary gas turbine for more efficient fuel injection

Additive manufacturing in energy technology

01 Pre-Process

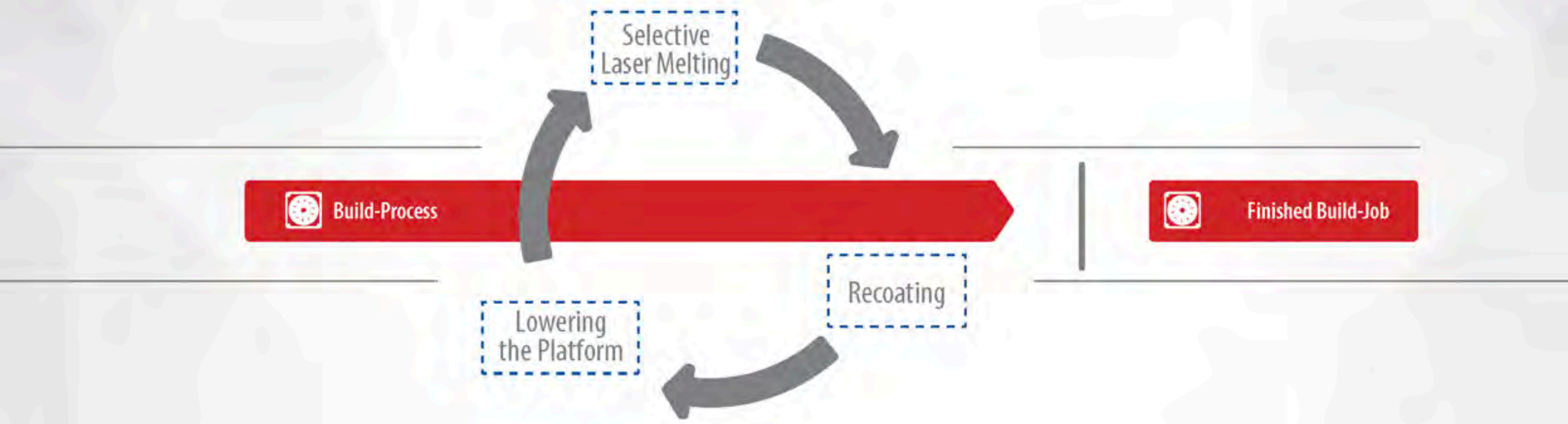


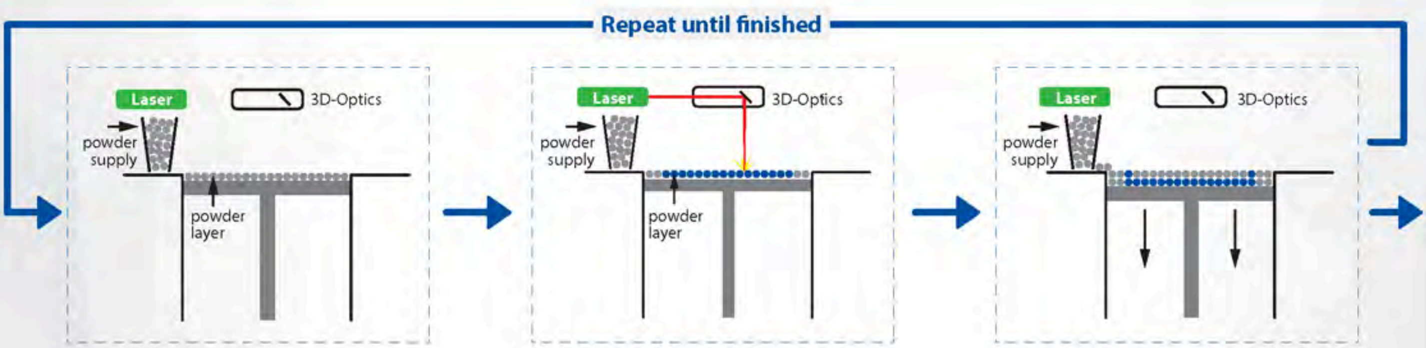
PRÄWEST chose SLM production technology to manufacture the swirler. The entire process chain is divided into three steps: pre-process, in-process and post-process.

Every component is based on a 3D CAD model, generated individually according to the needs and requirements of the customer. This is followed by an exchange of data between the CAD software and the processing software Magics. In the subsequent data preparation phase, the machine and materials are selected and the components are positioned on the substrate plate. The components can be placed either next to each other, inside each other (nesting) or on top of each other (packing). The combination of improved component arrangement and simultaneous production allows for significant cost reductions, as the fitting and auxiliary process times are lower depending on the component. The creation of supports helps secure and stabilize the components, and dissipate heat during the SLM process.

Process-relevant parameters like exposure vectors, exposure speed, laser power and hatching distance are then generated in the SLM build processor, either automatically or individually upon request. The selected parameters govern the component's thickness, surface accuracy and mechanical properties. Once the component has been „sliced" into individual layers along with the substrate plate, the layer data is generated, a process is known as hatching. The layer thickness (usually 30-50 µm) has a major influence on component quality in terms of dimensional accuracy and surface quality, as well as on the build time. The machine is prepared parallel to data preparation.

02 In-Process





Built on a Windows based user interface, the build job file is loaded onto the machine and the build process constructs the component layer by layer. The build process consists of the cyclical recoating and exposure of the metal powder. This is melted together along the component contours and surface areas defined in pre-processing. Next, the lifting table with the substrate plate is lowered by one layer thickness before a new layer of powder is added. This sequence is repeated, with the geometries of the current layer joining those of the previous one. The build job ends once the last layer of the component has been reached.

03 Post-Process

The unexposed powder is removed from the build envelope and sieved for re-use. The substrate plate with the component is removed from the machine, and any residual powder is vacuumed off. Heat treatment is possible at this stage, depending on the component requirements. After separating the component from the substrate plate, the support structures inside the flow channel are manually removed. In the next stage, known as plastering, the surfaces are manually ground to the required roughness in the channel, with the option of mechanical surface treatment. Finish turning machines the component tolerance, as well as the final outer contour. Any support structures still present in the outer contour area are then removed. Final testing is the last step in post-processing. Here, a variety of measurement equipment, coordinated measurement systems and 3D scans are used to ensure that the component meets the requirements from both the customer drawing and the model.

PRÄWEST

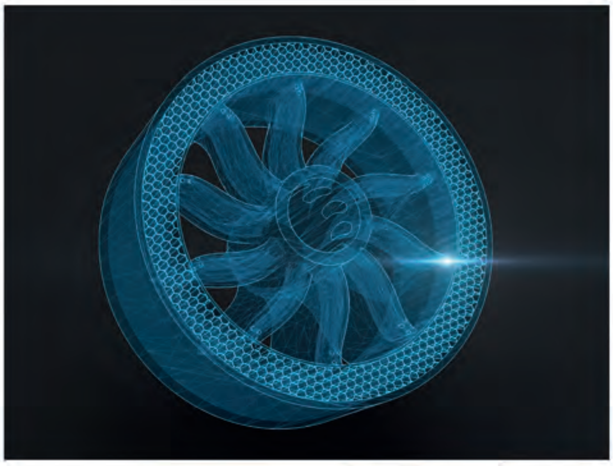
Founded in 1945, PRÄWEST has developed into a dynamic and innovative business. Acting as a contract manufacturer for the aerospace and turbo machinery sectors, the company came to specialize in reworking complex components. Its ultra-modern machinery park includes tools for milling, turning and grinding, with 130 CNC milling machines and 24 robots available.

PRÄWEST constantly invests in new technologies in order to meet the needs of its customers and one area of expertise is simultaneous five-axis machining for complex components. These systems can machine components up to 2,500 mm in diameter and 15 metric tons in weight in five axes.

One of the things PRÄWEST prioritizes is top-class customer service. Its highly qualified service staff work 24 hours a day, 365 days a year handling a wide range of customer requests. The company ensures its success by forging long-term relationships with its customers and suppliers based on trust, making customer service synonymous with "PRÄWEST-like".

How the Swirler uses SLM technology

PRÄWEST chose selective laser melting (SLM) production technology to help manufacture a modified fuel nozzle. Known as the Swirler, this component injects and evenly distributes fuel in the combustion chamber. The decisive factor here is enabling fast, even and complete fuel combustion through optimum distribution. The Swirler is made from the nickel-base alloy IN 718, boasting a very high resistance to corrosion. In the SLM process, the material typically has a tensile strength (Rm) of 1,230 N/mm².



The benefits of SLM technology

Cost Savings

The use of SLM technology to manufacture the Swirler reduced production costs more than 65 percent. Eliminating two steps from the traditional process also reduced production throughput time more than percent.

Functionality

Geometric freedom in component design is one of the main characteristics of SLM technology, allowing for greater component functionality. In the present example, SLM technology helps improve the geometry of the Swirler. An internal lattice structure and additional channels allow for functional optimization and integration. The lattice structure helps reduce the weight of the component, while also reducing the amount of material and resources needed.

Efficiency

Greater freedom for design changes also makes it possible to integrate new functions. In the example given, the efficiency of the turbine system has been improved. The high flexibility of the SLM technology therefore helps improve the component's efficiency. Tool-free production allows for design changes, while also ensuring lower costs and shorter manufacturing times. This makes the SLM process ideal for one-off and series production.

Flexibility

SLM technology makes it possible to make design changes that would not be technically or economically feasible using conventional production methods. In the SLM process chain, these changes are less time and cost intensive, making flexible adjustments cheaper and more efficient.

Time Savings

Shorter process throughput times are one of the main strengths of SLM technology, due to the integration of production afforded by the process that removes the need for auxiliary steps, such as clamping and set-up. In series production, pre-production process steps can be reduced by up to 50 percent. Another of the auxiliary processes in production, the time and cost-intensive preparation of data, is virtually eliminated.

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