

Case Study

Y-Connector for a Robotic Sander



**Design update and parameter optimization
lead to significant cost reduction**

3D-Printing Success Story

REDUCED MANUFACTURING COSTS

40% savings through DfAM and nested build orientation

OPTIMIZED PARAMETERS

Reduce build time 25%

COMPONENT OPTIMIZATION

50% weight savings with improved performance

Part Data

Designation:	Y-Connector
Industry:	Power Tools
Material:	AlSi10Mg
Layer Thickness:	60 µm
Build Time:	2d 8hr 11min (full load, 120 pieces)
Machine:	SLM®280 Twin



SLM®280

Current Situation

Traditional manufacturing suffers from high costs, long supply chain and limited design

Etteplan was tasked with redesigning the y-connector of robotic sander's dust extraction channel, optimizing it for additive manufacturing (AM). The existing, traditionally manufactured component suffered from high costs, a long supply chain and a too large footprint that caused problems in the assembly line. The customer hoped for a new solution optimized for laser powder bed fusion (LPBF) production in aluminum that was

significantly lighter than the original with improved airflow characteristics and produced at lower cost.

Etteplan assembled a team that included experts in AM production, design and print process simulation. Both Etteplan's own additive manufacturing production cost estimation tool and AM process simulation software were utilized throughout the design process.

Innovations with Selective Laser Melting

Expectations exceeded as all requirements met with metal additive manufacturing

Etteplan's first design for additive manufacturing (DfAM) iteration of the extraction channel smoothed the internal air channels and removed excess material from the design. At this point, process simulation software was used to conduct an orientation optimization to analyze the effect of print orientation on build time, support volume, needed post-processing effort and predicted deformation/distortion levels. Two orientations of the extraction channel produced comparable and preferred results in terms of support volume, post-processing and deformations. These orientations resulted in the longest print times for the manufacture of a single component, but conversely they required the minimal area footprint on the build plate, thus when the build plate was fully nested with the components, the per-part print time was actually lower than the other orientation options.

Once oriented on the plate, additional modifications were made to the design to improve printability and eliminate the need for support structures in regions that would be visible to the end-user after assembly in the sander. Print process simulations were used in order to determine where support structures would be required, to ensure that print-direction distortions would not

cause collision with the recoater during the printing process, and to check that the final distortion levels of the component were within the requirements.

The Etteplan AM cost estimation tool was also utilized during this stage to estimate and compare the costs of various design options with the original, traditionally manufactured part. It was found that for the amount of material and print time needed, it was too expensive to additively manufacture a single part. However, printing 11 parts at once was determined to be the threshold of where the traditionally and additively manufactured components cost approximately the same amount.

Further design changes were made to maximize the number of nested parts produced in a single build. Optimizing the design to allow components to be stacked 4-high in the print direction meant that a total of 120 pieces could be printed in one job on an SLM®280 selective laser melting machine, far exceeding the break-even price with traditional manufacturing. Process simulation was again used to estimate the support structures needed and to simulate the print process for a stack of four extraction channels.

SLM Solutions Consulting

Parameter development tailored toward process specifications further reduce build time 25%

For the 4-stack extraction channel design, Etteplan worked with the consulting team at SLM Solutions to optimize the process parameters for speed. While many of SLM Solutions' customers operate in critical industries where mechanical properties are of utmost importance, the dust extraction channels are not significant load-bearing structures and do not require fully dense material with the best mechanical properties achievable with the SLM® technology. Therefore, a unique process parameter approach was chosen allowing certain regions of the end component to be slightly more porous to allow a significant reduction in print time to further increase cost savings.

Particularly in the non-visible regions of the part, i.e. the threaded inlets and outlets, parameters optimizing speed were utilized. The standard, high quality process parameters were assigned to the rest of the component to ensure an optimized surface finish for the end-user.

Additionally, application engineers at SLM Solutions optimized the support structures to both minimize material usage and make powder removal easier. By teaming with the SLM Solutions consulting team, the print time of the fully stacked SLM®280 build was reduced by an additional 25%.

Etteplan's final design of the dust extraction channel met and exceeded all their customer's initial AM design objectives. Close collaboration and good communication between the customer, Etteplan, SLM Solutions and the service bureau 3Dstep who produced the part was essential for the success of the project. It also depended on the combined expertise of the assembled project team who were able to harness the design freedoms of AM with a strong understanding of the manufacturing process to produce a high-quality product at low cost.

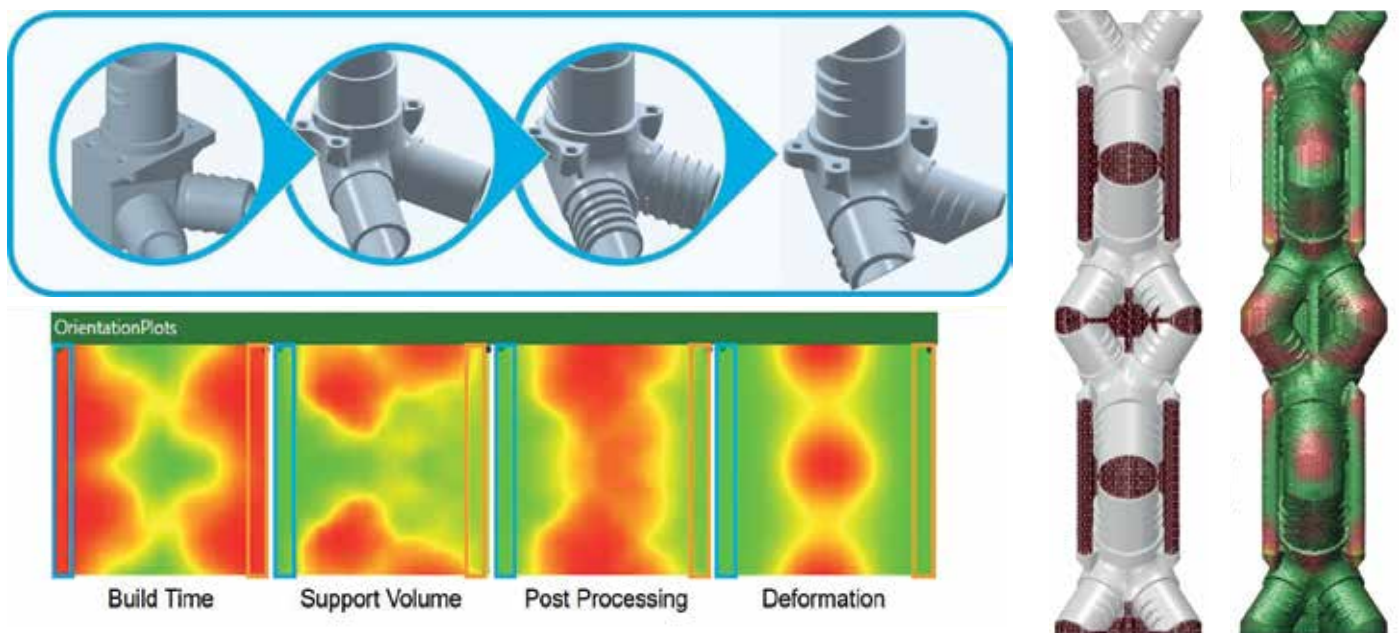


Fig. 1- 4, clockwise from top

The design evolution, starting with the traditionally manufactured component. Process simulation of the four-stack with support structures and distortion results with increased levels of distortion shown in red and yellow. Color plots helped decide the best orientation for the part based on four criteria options.

Summary

Dust extraction channel of a robotic sanding tool

- Manufacturing cost was reduced by 40% compared to traditional methods through design optimization by Etteplan
- An additional 25% build time reduction at 3Dstep was achieved through parameter consulting and optimization by SLM Solutions, resulting in additional production cost savings
- New design reduced weight of the component, printed in aluminum, by 50%
- Airflow characteristics of the extractor channel were improved
- Assembly was simplified through the introduction of a new tube connection thread
- Component codes were printed directly on the surface



Fig. 5:
120 stacked, nested connectors printed in one process on the SLM®280 by Finnish service bureau 3Dstep Oy.

Etteplan Oyj

Etteplan provides solutions for industrial equipment and plant engineering, software and embedded solutions, and technical documentation solutions to the world's leading companies in the manufacturing industry. Their services are geared to improve the competitiveness of their customers' products, services and engineering processes throughout the product life cycle. The results of Etteplan's innovative engineering can be seen in numerous industrial solutions and everyday products.

In 2018, Etteplan had a turnover of approximately EUR 236 million. The company currently has more than 3,500 professionals in Finland, Sweden, the Netherlands, Germany, Poland and China. Etteplan's shares are listed on Nasdaq Helsinki Ltd under the ETTE ticker.

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SLM Solutions - Technology Pioneers, Innovation Leaders

SLM Solutions helped invent the laser powder bed fusion process, was the first to offer multi-laser systems and all selective laser melting machines offer patented quality, safety and productivity features. Taking a vested interest in customers' long-term success in metal additive manufacturing, SLM Solutions' experts work with customers at each stage of the process to provide support and knowledge-sharing that elevate use of the technology and ensure customers' return on investment is maximized. Optimal paired with SLM Solutions' software, powder and quality assurance products, the SLM® technology opens new geometric freedoms that can enable lightweight construction, integrate internal cooling channels or decrease time to market.

A publicly traded company, SLM Solutions Group AG focuses exclusively on metal additive manufacturing and is headquartered in Germany with offices in China, France, India, Italy, Russia, Singapore and the United States and a network of global sales partners.



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