CASE STUDY

Volkswagen & Additive Industries

Volkswagen realizes a 650% cost reduction on Tiguan production tooling using the MetalFAB industrial metal Additive Manufacturing equipment

Abstract

Through manufacturing their Tiguan production tooling on the Additive Industries MetalFAB system, VW has achieved a 650% cost reduction, along with a significant reduction in lead time, and the ability to quickly iterate designs with improved performance.

Volkswagen Group Overview

The Volkswagen Group with its headquarters in Wolfsburg is one of the world's leading automobile manufacturers and the largest carmaker in Europe. The Group is made up of twelve brands from seven European countries: Volkswagen, Audi, SEAT, SKODA, Bentley, Lamborghini, Porsche, Ducati, Volkswagen Commercial Vehicles, Scania, and MAN. The Group operates 120 production plants in 20 European countries and a further eleven countries in the Americas, Asia, and Africa. Each working day, 43,000 vehicles are produced by around 630,000 employees who are involved in vehicle-related services, or work in the other fields of business. The Volkswagen Group sells its vehicles in 153 countries.

Introduction to the use case

As an innovative car manufacturer, Volkswagen Group invests in advanced manufacturing technologies such as Metal AM. Volkswagen produces various parts from tooling, prototypes, and small series with their own MetalFAB industrial 3D metal printing system. This case study showcases a specific tooling nozzle, used in the mass production process of the VW Tiguan.

The main impact of this application is the 650% cost reduction realized in the production process of a mainstream VW passenger vehicle. This is a very significant achievement for the Metal AM, which has been traditionally linked to Racing or Luxury car applications. With this case study, we demonstrate that due to the high productivity rate that the Additive Industries MetalFAB system has achieved, Metal AM is now ready to be competitive and cost-effective in the Automotive sector.

Component Overview

The tooling nozzle is a component used during the VW vehicle's assembly process. Each car model has its own unique nozzle and this case study is focused on the design used during the assembly of the VW Tiguan. During the car assembly process, the tooling nozzle is attached to a robot arm which sprays a liquid PVC rope at the flanges of the front and rear doors of the car. The rope is applied to protect the door against water-induced corrosion. Conventionally, the nozzles are made of two titanium machined parts, that are bent and welded together (see Fig. 1). Many different manufacturing and post-processing steps are required in its manufacture.

From a technical perspective, the accuracy of the nozzle outlet is a critical requirement to ensure the quality of the PVC deposited rope. More than 1000 nozzles per year are required for the VW Tiguan car production in Wolfsburg. Previously, VW outsourced the manufacture of these nozzles, which impacted both the cost and lead time of production.

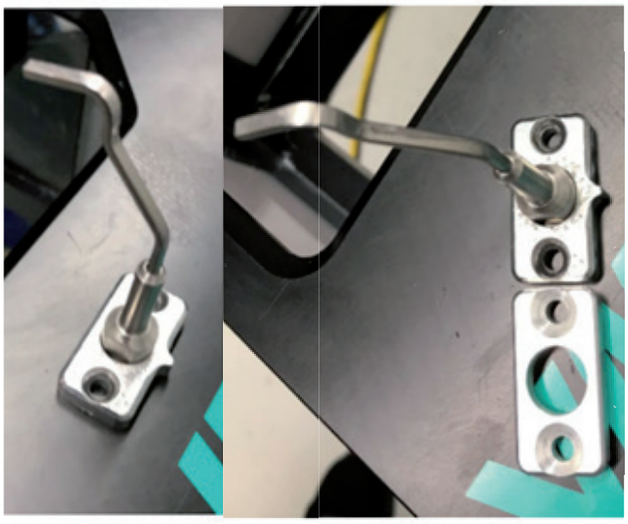

Figure 1

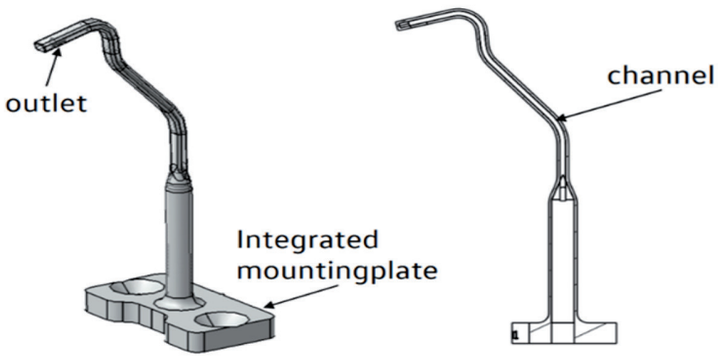

Figure 2 The redesigned nozzle for AM

Part benefit added through AM and MetalFAB system

The high production cost and lead times involved through conventional manufacturing of these nozzles were the main drivers for VW to pursue an AM solution. In addition, added value has also been realised via part consolidation & a streamlined manufacturing chain.

Part Consolidation:

The conventionally manufactured nozzles are made of 2 machined parts that are then bent and welded together, requiring various manufacturing and post-processing steps. The machining steps involve turning and milling, whilst post processing & assembly includes fixturing, welding, and subsequent heat treatments.

Design for AM (DfAM) has been used for re-designing the nozzle resulting in one single part that is manufactured in a single step using the MetalFAB system. (Fig. 2). The use of process simulation tools and the build to build repeatability of the MetalFAB has achieving the desired shape and dimensional tolerances in as-built conditions build after build. Meaning no further post-processing steps such as heat treatment or machining are required. This drastically reduces the lead time for manufacturing.

Cost reduction:

The use of Metal AM for producing these VW Tiguan nozzles has allowed a cost reduction of 650%. This has been possible due to:

- Part consolidation and the related removal of various manufacturing steps

- Drastically reduced material usage, a typical benefit of additive manufacturing vs. a subtractive manufacturing process.

- The ability to use a cheaper material; conventionally the nozzle was manufactured from Titanium, which is an expensive alloy. Exploiting the freedoms for metal AM & optimising the design for the process, has enabled the possibility to use a cheaper Stainless Steel alloy without compromising on the mechanical performance of the part.

- Exploiting the fully automated and high productivity MetalFAB system, has condensed the manufacturing lead time to 2 days. The large MetalFAB build envelope, in combination with 4 full field lasers, enables the production of 48 parts in one build, in only 15 hours. Moreover, the automatic depowering system integrated into the MetalFAB system enables further post-processing time savings. Once built, the parts only require detachment from the build plate and minimal support removal.

Rapid Prototyping and Design Optimization:

the use of Metal AM also allows a rapid and more efficient prototyping phase for the nozzle geometries, which are different for each car model. This possibility will have a significant impact on the development time of new and/or optimized designs for other VW vehicle models.

All these advantages have enabled Metal AM to penetrate the Automotive mass-production sector; a high volume cost sensitive industry, where traditionally AM has struggled to thrive.

Part Manufacturing Process Details

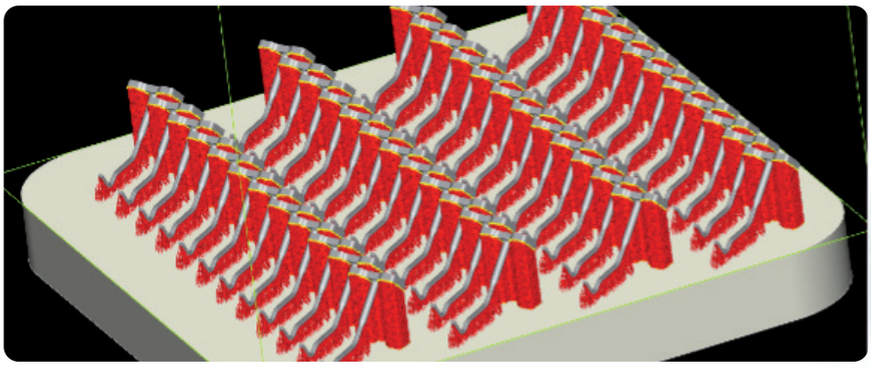

Figure 3 Nozzle build job layout

Figure 4 The 316L tooling nozzle manufactured with MetalFAB

The nozzles build job has been prepared in an optimised orientation and support structures added. The geometry has been simulated and pre distorted, to reduce any deformation of the final parts. Highly productive SS316L process parameters provided by Additive Industries, have been assigned to the build.

The build layout (Fig. 3) is then printed with the MetalFAB system and its automatic powder removal feature. 48 tooling nozzles fit the system build platform, and, thanks to the 4 lasers working in parallel, the printing time is only 15 hours. After printing, the nozzles are easily removed from the build platform and the weaker support structures are manually removed.

Every nozzle is then inspected optically and using a pass/fail jig, checking the fit & form of the parts, before being assembled onto the robot arms ready for use. The total lead time for this manufacturing process is 2-3 days. This is a huge time saving when compared with the weeks needed for the conventionally manufactured components. Thanks to the design optimization and process simulation, it has been possible to avoid any post-machining or heat treatment steps.

The AM nozzle is made of 316L Stainless Steel which is much cheaper than the Titanium alloy previously used. The combination of material change and optimized AM design, maintains the mechanical performance required for the tooling nozzle. Future development will involve the use of harder tool steels, already available on the MetalFAB system, for the nozzles that require more stiffness.

Feature	Value
Material	316l
Processing set	50µm
Printing time per part	19 minutes 48 parts on a build which takes 15 hours to print
Internal channel diameter	1mm
Wall thickness	0,5mm
Area in the car	Door front and rear, PVC rope at the flange
Type of car tooling is used	Tiguan

Conclusion

This project, born from the collaboration between Volkswagen and Additive Industries' newly launched "Additive Studios: Additive Manufacturing professional consulting services & training programs", has demonstrated the significant business case benefits, especially in terms of cost and time, that the MetalFAB system can bring in the Automotive mass production sector. Being one of the first projects which have demonstrated an important cost reduction in the daily application of this sector, where Metal AM has traditionally struggled to penetrate, the AM nozzles has been shown to be an interesting business case that will inspire and create more applications in similar production environments.
The project is among the selected finalists of TCT AWARDS 2022 in the Transport Application category.
This part is patented by Volkswagen under patent DE 10 2019 206 492 A1

> At Additive Industries, our objective is the success of our customers in achieving the lowest cost per part at market leading part quality. We pride ourselves on our fl exibility to work with our MetalFAB users in achieving their industrial goals.

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