WÜRTH Industrie Service

DE | **EN**

CPS®WAM
WÜRTH ADDITIVE MANUFACTURING

NEW POTENTIAL THROUGH 3D PRINTING

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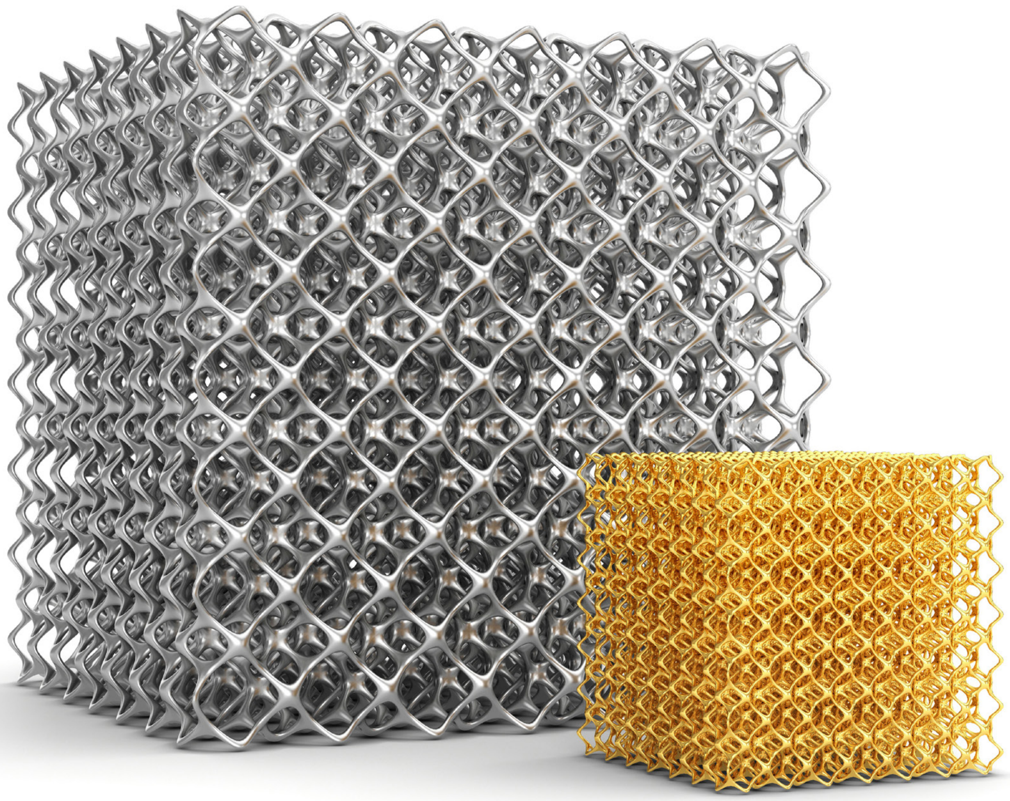


FOREWORD

Dear customers,

Additive manufacturing, also known as 3D printing, has been used for plastics engineering for many years. This manufacturing process has a great deal of innovative potential applications for many areas, including architecture, design, medical technology, packaging design, and mechanical engineering. We at Würth Industrie Service GmbH & Co. KG consider it as important tool to expand our range of services in mechanical engineering and construction. Applications include utilizing additive manufacturing technology to produce initial samples, prototypes, series parts, spare parts, and tools. Additive manufacturing allows us to start from batch size "one" and manufacture quickly, locally, and cost-effectively from one single source, without limiting ourselves to the traditional C-Parts supply chain.

From large items to small items, small series to full-fledged series production, and production of spare parts, Würth Industrie Service has an extensive production portfolio, and has built an effective network of additive manufacturing partners. This gives our customers maximum freedom to develop and implement these partners' products, including the materials used for industry components. Würth Industrie Service has established itself as the premier C-Parts partner for the industry with over 20 years of expertise in the market. By offering additive manufacturing, the company has expanded its portfolio by further product groups, offering A and B parts in addition to C-Parts. Today, C-Parts supply is no longer just about delivery of the required items. Instead, it is also about an intensive cooperation with the customer, a comprehensive knowledge of goods and material flow, and a deep integration in the existing process landscape. In this way, Würth Industrie Service can be involved in every aspect of development and implementation of our customers' components, and be a project partner offering cutting-edge technology in all areas to create a finished part from a 3D printer, according to our motto: All from one single source!

p.p. Dennis Birresborn
Department head - technology

INTRODUCTION

Increasing innovation pressure and shorter product development periods challenge manufacturing companies to respond quickly to the rapidly changing requirements of the market and customer needs, while maintaining a high level of quality. An innovative and niche technology—additive manufacturing, also known as 3D printing—offers new solutions to these challenges.

In 3D printing, material is added together layer by layer to create three-dimensional products without using any tooling or cutting. Changes made in a virtual model can be quickly transferred to a physical prototype. This helps in repairing flaws, and detecting potential for optimisation. Additive manufacturing is particularly suited for manufacturing initial samples, prototypes, and spare parts, as well as tools and small series. From high-performance, rubber-like or transparent plastics, to aluminium, stainless steel, tool steel, and high temperature-resistant steel or titanium: the best material for each application can be selected from a variety of options.

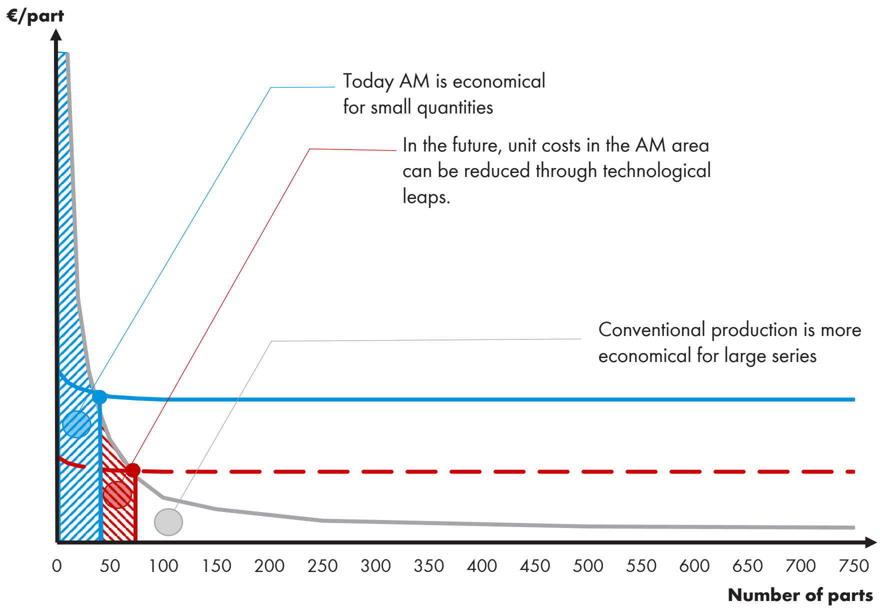
Our experts in the field of additive manufacturing will gladly advise you as you implement this technology in your production, and support you during product development. By applying our industry experience, expertise in conventional and innovative manufacturing processes, and knowledge of your process landscape, we will work with you to select the procedures that are best suited to your individual needs. In doing so, we do not limit ourselves to C-Parts, but also offer our services for A and B-Parts. We collaborate with efficient and specialised partners to offer you a complete range of promising manufacturing technologies and CAE software tools.

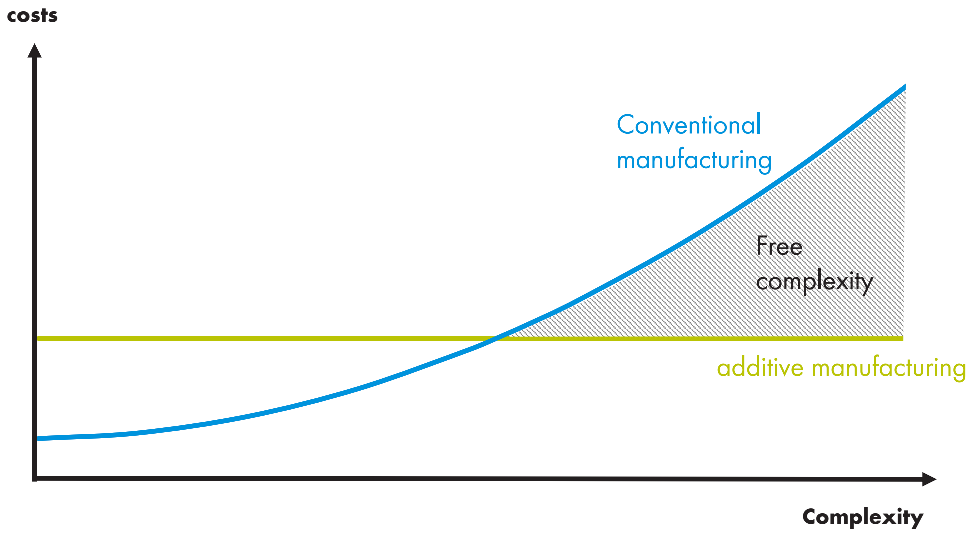
Additive manufacturing is based on a CAD volume model, which can be created using two-dimensional design data as a starting point. Physical parts can be scanned and then redesigned in a process called Reverse Engineering. The digital twin of the product helps to increase efficiency and quality of the process by allowing us to detect weaknesses and optimize component features during the product development phase.

BENEFITS AND USES

- High level of freedom in designing
- Purpose-fit material choice
- Repair applications
- Reduced assembly efforts
- Manufacturing to specific requirements
- Customised mass production
- Reduction in lead times
- Elimination of minimum purchasing quantities
- Tooling no longer required
- Cost reduction
- Shorter delivery times
- Rapid product development

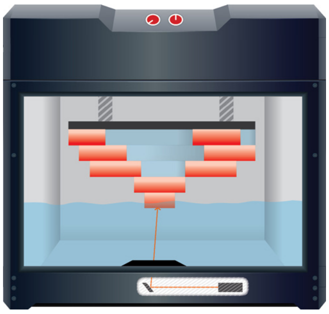
PROFITABILITY ANALYSIS



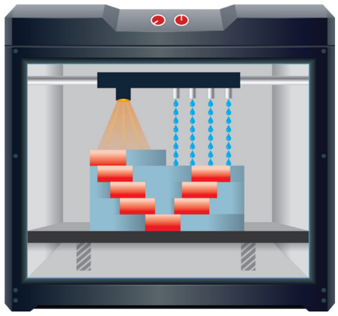


PROCEDURAL OVERVIEW

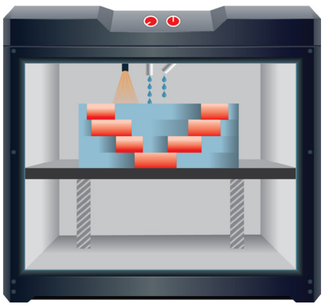
Stereolithography (SLA)



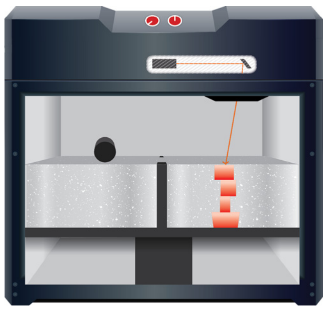
PolyJet™



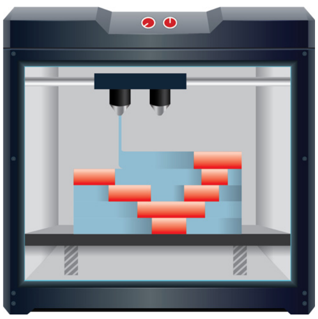
Multi Jet Fusion



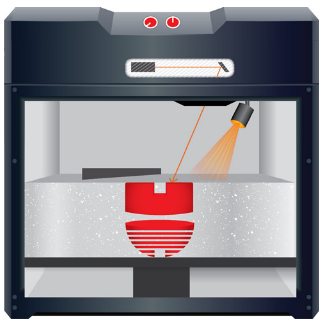
Metal 3D printing



Material extrusion



Laser sintering



MATERIAL UND TECHNICAL DATA

Metals

- Aluminium (ALSi10Mg)
- Titanium (TIAL6V4)
- Stainless steels (1.4404, 1.4542, 1.4057)
- Tool steels (1.2709)
- Inconel IN 718
- Hasteloy X
- Coating thickness 15 – 500 µm
- Average roughness Rz 20 – 50 µm
- Accuracy in 3D printing ± 0.2 mm

Plastics

- Polyamide 12
- Aluminium-filled polyamide
- Marble-filled polyamide
- Flame-retardant polyamide
- Polyamide TPU 92A-1
- PEI
- Polypropylene (PP)
- ABS, PLA, ASA
- Temperature resistance 40 – 220 °C
- Accuracy in 3D printing ± 0.2 mm
- Achievable coating resolutions 0.016 – 1.5 mm

Finer surfaces and higher accuracies can be achieved by subsequent post-processing. The maximum dimensions of the components depend on the manufacturing processes and the manufacturing material. Additional materials are available on request.

DETAILED EXCERPT OF PROCEDURE

Fused Filament Fabrication

Thermoplastic filament is melted in the print head, and is applied in layers via a carrier material in a cordlike form.

Benefits:

- Widely-used technology
- Very low procurement costs
- Large diversity of materials
- Easy process and material handling
- Little wastage
- Thermally resistant

Disadvantages:

- Anisotropy in Z-direction
- Low process speed
- Poor surface quality
- Use of support structures
- Time-consuming post-processing

Laser Sintering

Plastic powder is added in layers using a recoater in a pre-tempered space, and then the contours are fused together with a laser beam.

Benefits:

- Good mechanical properties
- No support structures required
- Good surface quality
- Maximum freedom in designing
- Thermally resistant
- Low coating thickness ~ 80 μm

Disadvantages:

- Monochromatic models
- Long heating phase
- Long cooling phase
- Periphery required

Metal 3D Printing

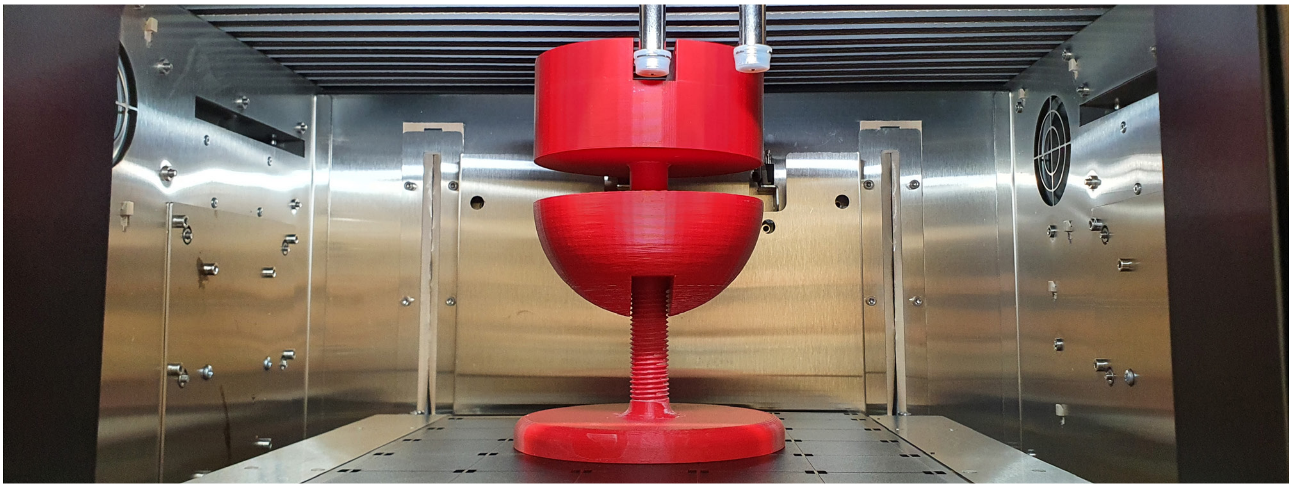
Powdered metal is added in layers using a recoater, and then the contours are completely and locally re-melted with a laser beam.

Benefits:

- Manufacturing of metal components with ~ 99.9% density
- High mechanical and thermal stress of components possible
- Powder recycling

Disadvantages:

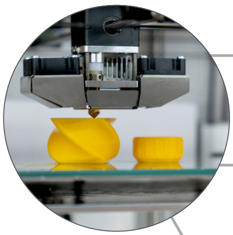
- Proportionately high surface roughness (powder adhesion)
- Demanding process control
- Time-consuming post-processing
- Cost-intensive




WÜRTH

ADDED VALUE

Importance of 3D Printing - Different Methods to Acheive Desired Result



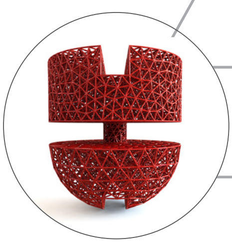
PROTOTYPES: Reduced product development time

SPARE PARTS AND AUXILIARY PARTS:
Create custom tools, forms and mounting devices

CUSTOMISED PARTS:
Customer-specific contract manufacturing

INNOVATIVE PRODUCTS: Optimised and lightweight components, integrated functions

BRIDGE MANUFACTURING: Available from lot size "one," small series production



BIONIC PARTS: Upon request

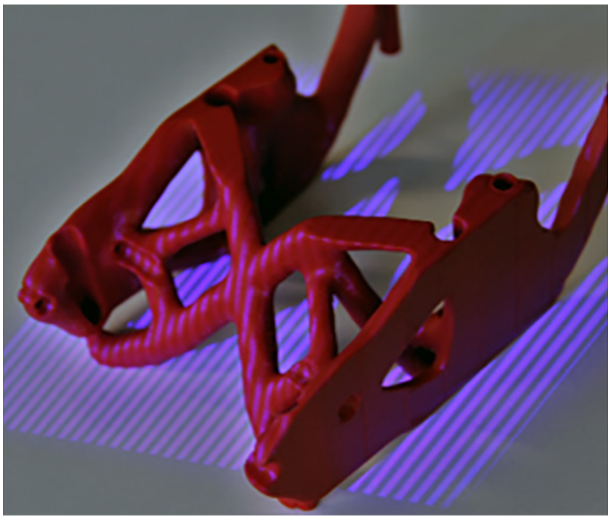
3D printing parts with
added value leads
to economic success!

REVERSE ENGINEERING

Actual components can be recreated using 3D scanning. This eliminates the process of cumbersome redesigning of components. You can scan a component to create a digital twin, which is mapped precisely to the product. This digital twin can be used to manufacture spare parts, or to continuously monitor the quality of the products. By transferring the measurement data to a design software, it is also possible to fix defective component designs.

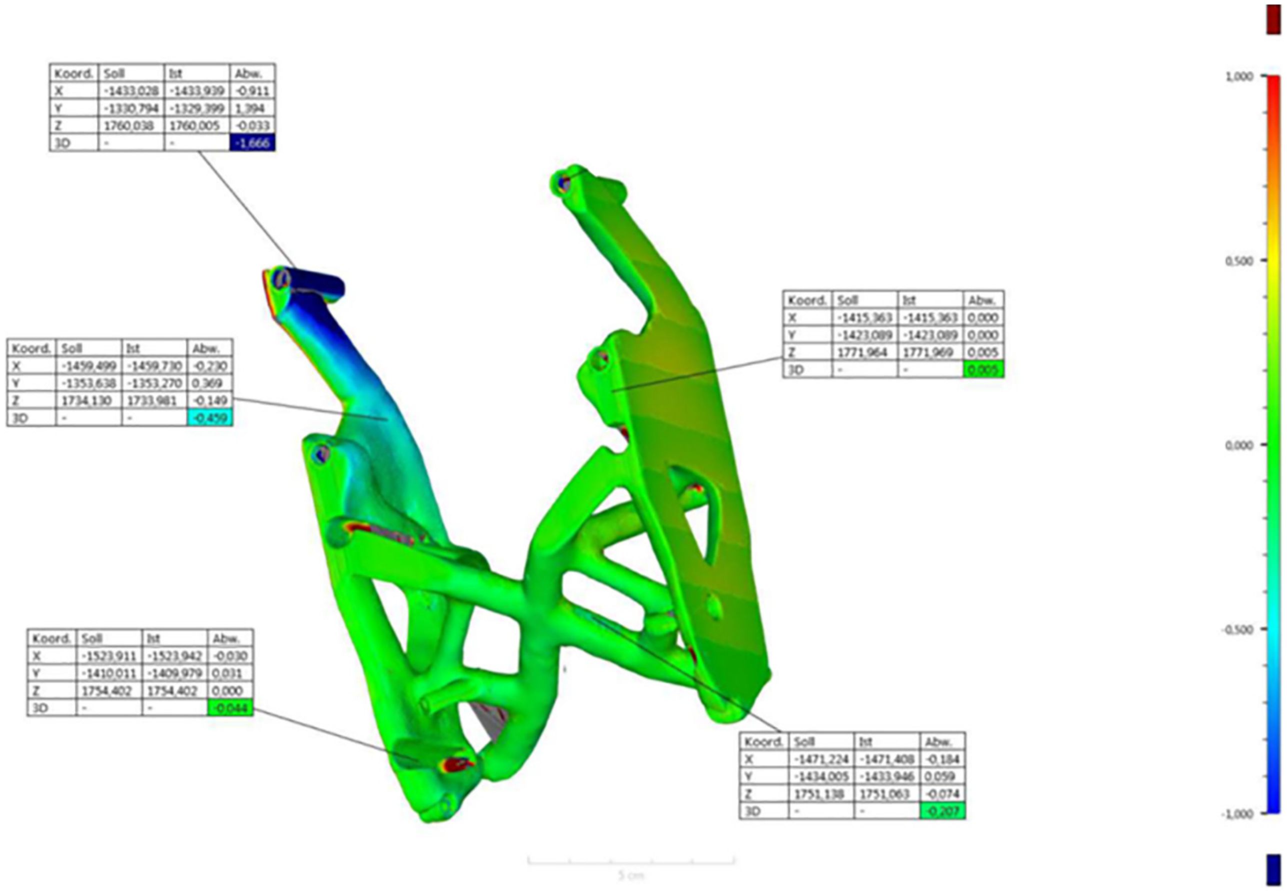
Procedure:

1. CAD model is not available
2. Actual component is scanned
3. Actual CAD model / digital twin is developed
4. CAD model can be adjusted and optimised



Digitalised Real Component

Constructed CAD Model



Quality Assurance:

Quality has to be consistent to be able to fulfil customer requirements, and deliver reliable products over the long term. Even the slightest deviations can seriously impact series products as well as prototypes. These deviations can be detected quickly and cost-effectively by comparing the surfaces of the digital twin of the product created by 3D scanning, to the previously designed CAD dataset of the component.

1. Target CAD dataset is available
2. Actual component is scanned
3. Actual CAD model / digital twin is developed
4. Datasets are compared

In addition to using this technology for in-house products, we also offer this to our customers as service on any components.

PRODUCT DEVELOPMENT

By using new and future-oriented production technologies, individually tailored to the needs of a customer, it was possible to implement a new development project successfully and build the foundation for a long-term supply as well as a business relationship.

For a long time, our customer, Vaillant, was looking for a flexible solution to reliably close an exhaust pipe during maintenance, and keep the seal gas-tight and acid-proof to ensure the safety of the service staff.

Our core, logistics, was an important part of the project and ensured that the customer received a final, assembled product, separately packed and labelled, in exact required quantity at the desired delivery time.

Customer Request

The customer, Vaillant, consulted international sales employees at WIS regarding an application solution to reversibly seal the exhaust pipes of gas heaters during maintenance. No standard solution was currently available.

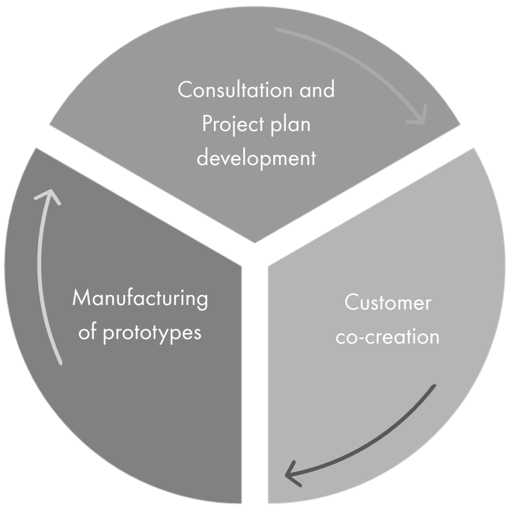
Customer Requirements

- Pipe diameter greater than opening of maintenance flap
- Working around difficult-to-access maintenance area
- Gas-tightness
- Temperature resistance

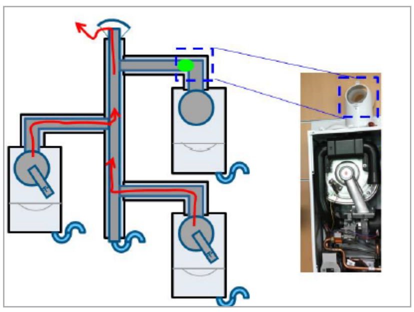
Objective

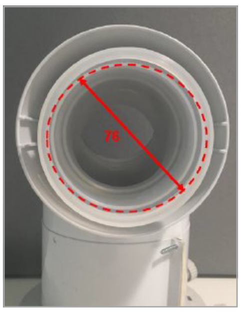
Exhaust pipe to be tightly closed at the time of maintenance to protect the employees in accordance with current legal framework.

Design and Development



Product Development incl. Specification and Tests





From 3D printed product idea to injection moulded series parts in a short time

This application has shown how important it is to be aware of the potential of additive manufacturing applications, and apply the technical know-how effectively in advanced manufacturing.

Vaillant

The detailed description of this technology is available on our website!

Release of Functional Prototypes

Thanks to 3D printing, a functional fourth prototype could be sent quickly to the customer. The series production was released after extensive testing.

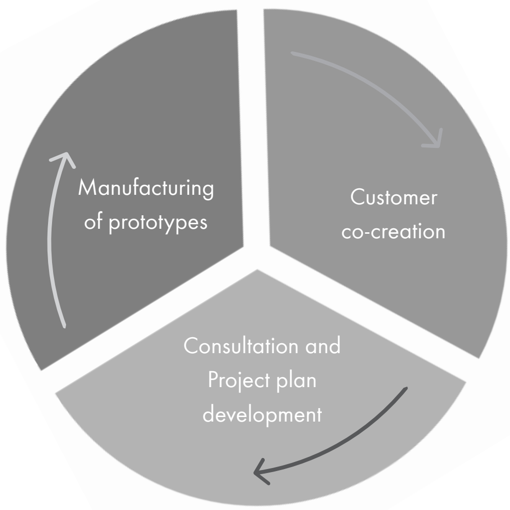
Manufacturing in Injection Moulding

Taking into consideration the annual purchase quantity of the customer, injection moulding was deemed more economical and the production was started in this procedure.

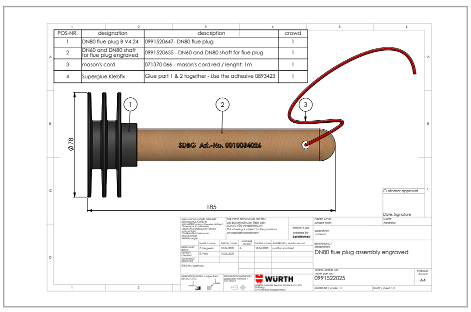
Logistics

It was important to integrate logistics processes to enable final assembly and individual packaging according to customer requirements, through the product department.

Initial Sampling & Series Release



Design Freeze, Procurement & Logistics



TOPOLOGY OPTIMISATION

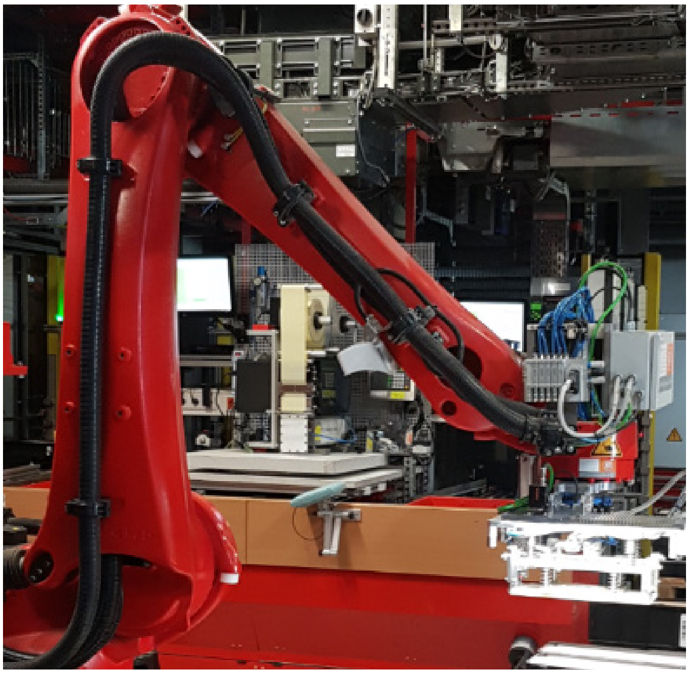


Image 1: Photo of KUKA robots from logistics at WIS

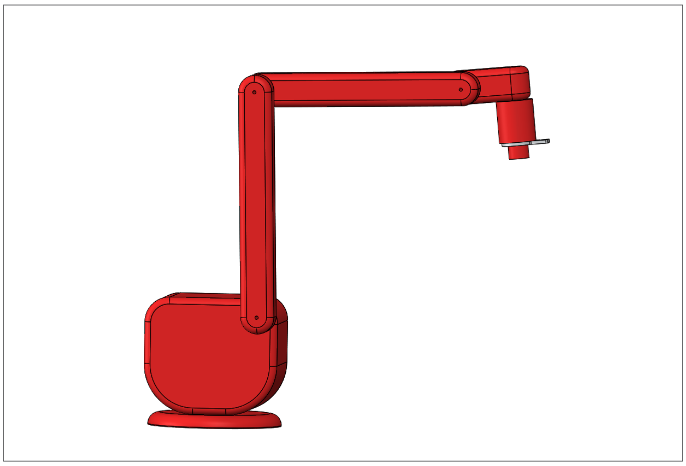


Image 2: "Digital twin" model of robot to determine the tension

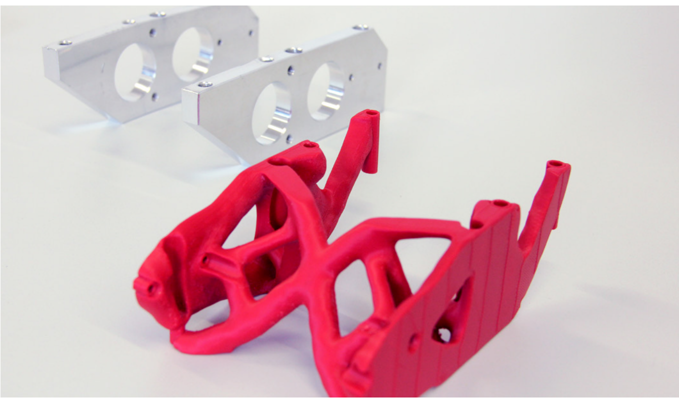


Image 3: Original aluminium holders vs. 3D printed, topology optimised holder

New worldwide regulations and standardisations are increasingly urging organizations in different industries to manufacture components with a tension-optimised, lightweight design. Ideally, the material is only built up at those points where tension arises inside the component as a result of the acting forces of the mechanical process. This development trend is particularly sustainable as it protects the resources in the manufacturing phase and product lifecycle. Only the use of innovative manufacturing technologies such as 3D printing, together with advanced CAE software, make it possible to overcome conflicting goals, such as high stability despite low material requirements.

In the logistics centre at WIS, one of the most advanced in Europe, robots sort small load carriers, which are picked from the high-rack storage for shipping to the customer on pallets (see image 1). An aluminium plate equipped with a camera system and LED light-bands enables optical recognition. Due to the built-in components, the deployed light panel system is sensitive, expensive to manufacture, involves high assembly effort, and lead times for its repairs are long. An improved design was created to reduce component costs, repair expenses, and downtime, and successfully utilise the advantages of lightweight design for the dynamic load cases.

In the following project flow, the dimensions and masses of individual components have been determined, the movements of robots have been analysed, and a digital twin has been designed (see image 2). It was then possible to conduct a structural analysis with the collected data. With the help of the digital twin, we could identify how the acting acceleration forces could impact the parts of the robot, and which inner component tensions and component deformations could occur as a result. The multibody simulation that was generated forms the basis for creating a topology-optimised holder in the next step, which is expected to achieve optimised strength and improved design for the application, resulting in enhanced compatibility of individual processes of gripper change.

The result of the project is a structural component optimised for lightweight design, which has a mass of approx. 87% of the original structural component but still withstands the acting forces (see image 3 and image 7).

In event of a crash, a predetermined breaking point adapted to the application has been implemented in the holder (image 3). As a result, there is no need to exchange the whole structural component in the event of repair, but only replace the relevant individual part.

In addition to reduced downtimes due to repairs, the efficiently streamlined design hast the potential to save costs, accounting for approx. 94% of the current annual repair costs. Thus, the lightweight design not only improved product design, but also resulted in overall optimisation—technologically, economically and ecologically.
We are looking into the future and looking forward to expanding our previous, promising findings, and gathering new experiences.

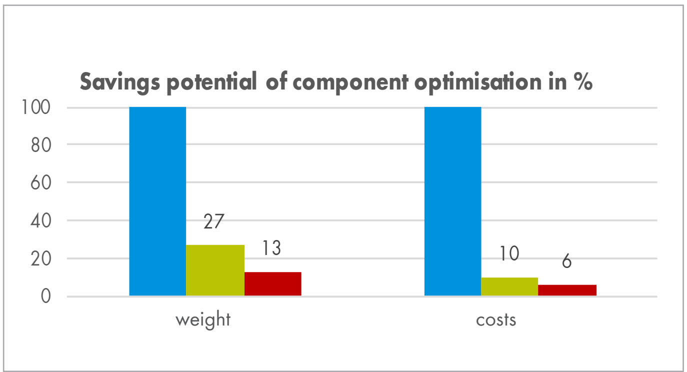


Image 4

Original component (image 5)
First optimisation (image 6)
Second optimisation (image 7)

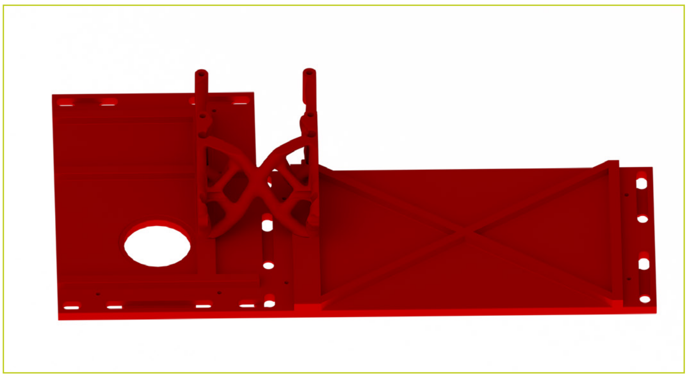


Image 6: First optimisation

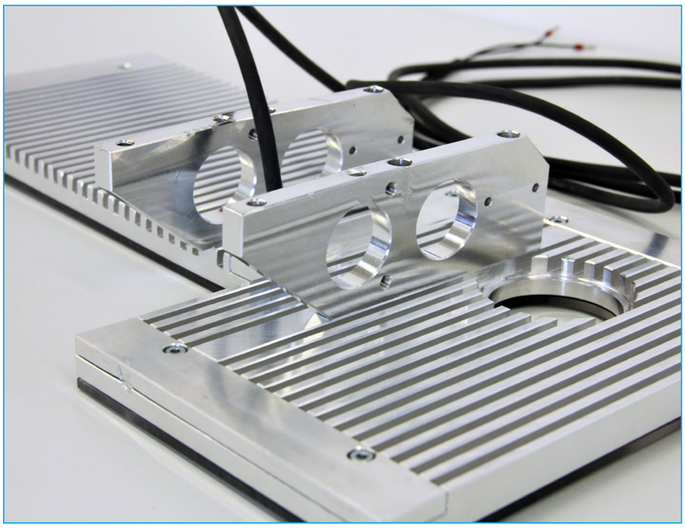


Image 5: Original component

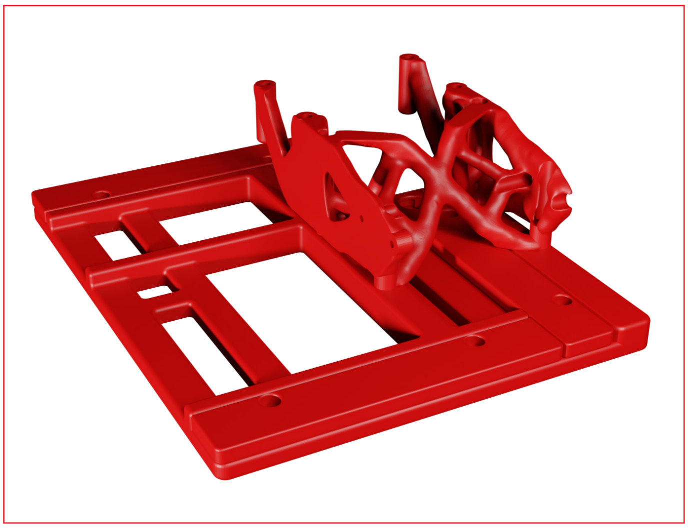


Image 7: Second optimisation

ACCREDITED TEST LABORATORY

Comprehensive expertise of our employees, active quality management, and advanced testing equipment—this is what distinguishes the accredited testing laboratory. The accreditation according to DIN EN ISO/IEC 17025, which is applicable since 2017 and for more than 50 standard-compliant test methods, serves as proof of our expertise and confirms that you can trust our tests. Do you want to test the main features of your printed components, for instance, according to DIN EN ISO 17296-3? Do you have normative or specific test requirements? We will gladly advise you on technical issues and develop customised solutions to meet your testing requirements. You can find the actual scope of accreditation on our website.

Additional information under

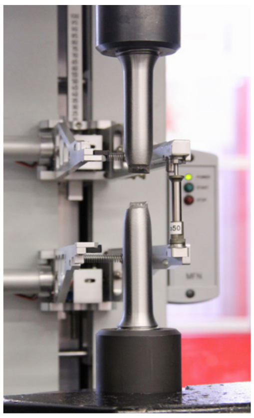
www.wuerth-industrie.com/labor

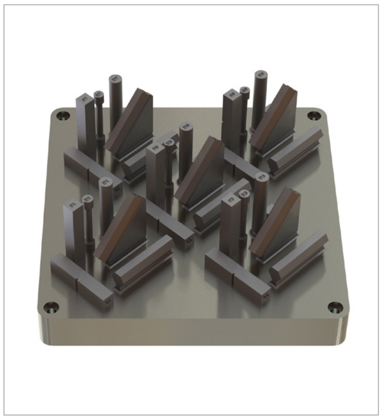
Here is an excerpt of our standardised test procedures.

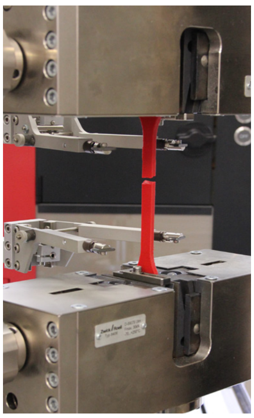
TENSILE TEST

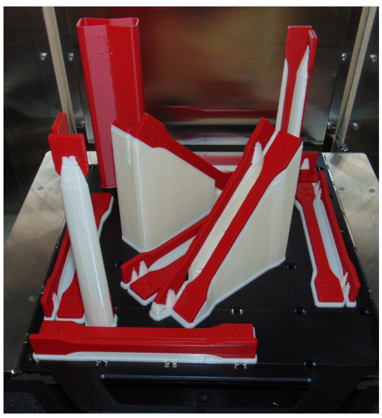
Tests round and flat samples on plastics and metals as per:

- DIN EN ISO 6892
- DIN EN ISO 527









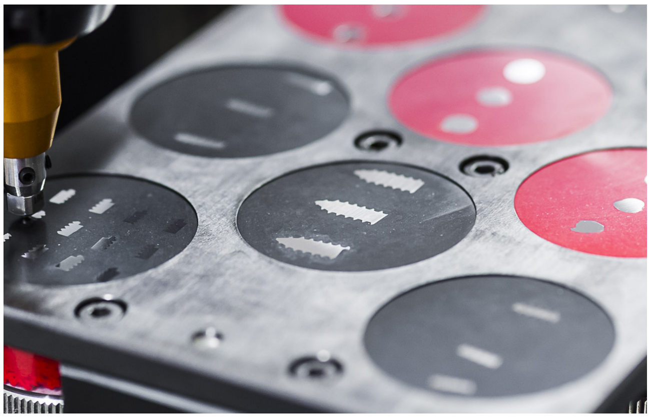
IMPACT BENDING TEST

- DIN EN ISO 148-1
- 300J of initial potential energy
- up to -80°C

HARDNESS TEST

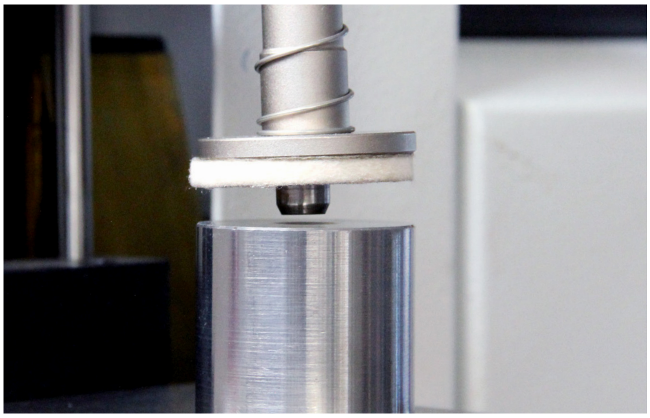
On plastics and metals as per:

- Vickers DIN EN ISO 6507
- Rockwell DIN EN ISO 6508
- Brinell DIN EN ISO
- Hardness traverses of different types
- Shore A, Micro Shore A



SPECTRAL ANALYSIS

- Optical spark emission spectrometry of steel and ferrous materials

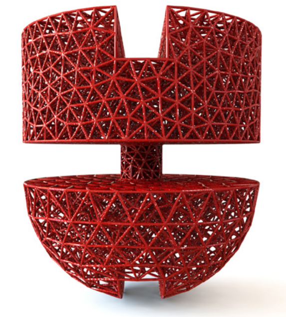


MICROSCOPY

- Microstructure
- Fracture surfaces
- Measurement
- Coating thickness
- Creation of pictorial documentations

YOUR DIRECT LINK

We are here for you! We will be happy to advise you:



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YOUR NOTES

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You will find additional information
on our homepage.