

# EXPLORING THE 3D PRINTING OF METAL VACUUM SEALS

## ARTICLE TYPE

RESEARCH ARTICLE  
This article reports on a research project that explored the possibilities of 3D printing metal vacuum seals. The project was funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska Curie grant agreement. The project was led by Dr. Sreten Savenja, who is currently a senior research fellow at the University of Birmingham, UK.

Correspondence: Dr. Sreten Savenja

3D printing has been on the rise for some time now. Starting from plastic jewellery and car body parts to functional brass and copper can now be printed, with industry experts continuously learning about how to optimise materials, machines, processes and procedures. The 3D printing of metal products for high-tech industrial applications remains quite the challenge however, with very demanding specifications in terms of accuracy, tolerances, surface finish, strength, etc. KMWI SCF joined forces with Settel's Savenja to build up experience in the 3D-printing of metal vacuum seals.

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## Research scope

The KMWI SCF business unit is researching the additive manufacturing, primarily focused on 3D printing, of metal structures and machine tools in collaboration with eight partners in the Additive consortium. Initial to the first 3D printing pilot factory for the production of industrial metal parts in thickness, and it is here that KMWI works on manufacturing for design, parameter optimisation, support strategy, material research and comparison with existing technologies to make world class additively manufactured parts.

The Research & Innovation team of Settel's Savenja, development department took part in Additive Design Challenge 2021 with a well-making vacuum seal designed for reducing construction space in high-tech vacuum systems for vacuum-related and process industries.

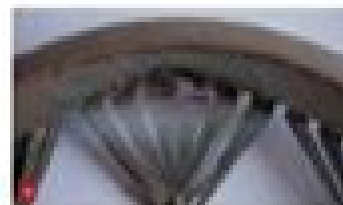
After meeting during the design Challenge final, KMWI SCF and Settel's started working together to bring the design to reality. KMWI is eager to learn about printing industrial products to machine metal and stainless, while Settel is exploring the opportunities to meet a new standard for vacuum seals.

To kick off the research, a pilot job was built using the original seal design, printed in an upright position and

supported by an added fixture. The position was chosen to minimise the total amount of supports and material required, including the machining effort for



1. First metal printed in 3D printing process, supported by the added fixture. The seal was printed in the upright position.



2. Printing the structure in an added fixture. Figure 1 shows the angle and on the picture after the 3D printing process the limited and most of the printing powder has been removed.

The prototype made during the first pilot job demonstrates the difficulty of printing the design and the tool manufacturing because of the choice of support structure (see Figure 1). The following observations can be made: a full structure support leads to printing powder remaining in the structure. It is a lot of post-processing time needed to remove structure and clean up the part.

A new approach leads to: it is rough surface finish because of the absence of support structure (see also marked 1 in Figure 2) or support structure that are too fragile (see also marked 1 in Figure 2). A low thermal conductivity in these areas near the surface is needed.

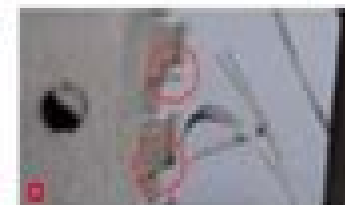
## Partners: KMWI and Settel's Savenja

KMWI is a leading industrial company located in the Netherlands, operating as both a supplier and partner for the high-tech equipment industry and process industry. The company operates in high-tech, low-volume, high-complexity manufacturing, it designs and delivers a wide range of complex, customised industrial components, average quality standards, competitive cost factors, reliability and delivery to meet the demands of customers in the medical, semiconductor, process and industrial automation sectors.

Settel's Savenja is a group of companies that provides high-tech manufacturing with expertise for people. The group focuses design, manufacturing, assembly and semi-finished products, machine, tools and equipment. Their international customer base like shipping, automotive, medical, aerospace and energy markets.

[www.kmwi.com](http://www.kmwi.com)  
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3. The model is made during the 3D printing process and the limited and most of the printing powder has been removed.



4. Single structure in the new structure which has automatically supported (see Figure 3).

## Examples of support structure

The vacuum seal design was optimised for 3D printing using the lessons learned from the first pilot job. The following principles were applied for the new design:

1. The product is placed at an angle of 1° off the vertical (upright) orientation with respect to the horizontal to avoid having to use vertical supports.
2. Structures are incorporated into the support structure, so the structure can be removed easily.
3. The support strategy changed from one supports to multiple supports, so there can be removed more easily (less processing). Changing from a closed to an open support structure means less material is needed.



5. Part of the second pilot job with a better support structure and a different support strategy.

During the same with the seal design, it was decided to also optimise for seal design built for printing. When a hole is required, most mechanical engineers will almost automatically choose a circular shape, as this can be easily made by machining on a lathe or a milling machine. Different rules apply for 3D printing however: a vertical printed circular hole requires a support structure, while a square hole does not. In such a square hole is cheaper and easier to make using 3D printing than conventional machining. Other constraints were made by reducing the amount of features, while still applying the Savenja's

# Parker Vacuum Seal Design Guide

**JG Myers**



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