



Your 10-point guide to WAAM technology

## Why WAAM is Taking Off in Aerospace

More than ever before, there is a need to adopt environmentally sympathetic manufacturing processes that will help resolve many macro and micro aerospace engineering issues. This is where the benefits of wire arc additive manufacturing (WAAM®) come into play.

## Here are ten top reasons why WAAM and aerospace work well together:

### 1 **WAAM is suitable for medium to large scale prototype and component development and repair.**

It exploits the power of MIG and plasma welding technologies to create medium-to-large scale three-dimensional metal structures.

- Laser Powder Bed Fusion (LBPF) can go up to 1m x 1m
- WAAM – to date the largest from WAAM3D is 6m x 2m.

### 2 **WAAM can be used as a stand-alone solution or integrated into other processes.**

As WAAM needs to start from base feedstock, it can be used to build each part from the ground up, or integrated alongside other techniques such as forging, casting or CNC machining, also for the customisation and repair of existing components.

### 3 **WAAM minimises expensive material waste.**

Because the part is built, layer upon layer, with molten wire deposited in a series of precisely controlled beads, WAAM's buy-to-fly ratio<sup>1</sup> (BTF) is reduced to <2, which leads to cost savings of up to 70% compared to machining from solid.

- BTF ratios ranging from 6 to 20 are typical for many titanium aeroengine components<sup>2</sup>
- WAAM produces a 15 kg aluminium wing rib with a cost reduction of 65% and a BTF ratio of 2.3, as opposed to 40 for machining from a solid blank<sup>3</sup>.

### 4 **WAAM can use a range of materials.**

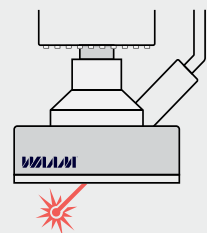
It avoids the expensive waste associated with machining materials such as titanium and can create structures in a range of materials (from titanium, aluminium, refractory metals, steel, bronze and copper to Invar®, Inconel® and magnesium).

### 5 **WAAM can create a wide range of aerospace components.**

It is particularly suitable for aircraft manufacturers looking for medium to large aircraft components such as bulkheads, cruciform, flanges, stiffened panels, and wing ribs.

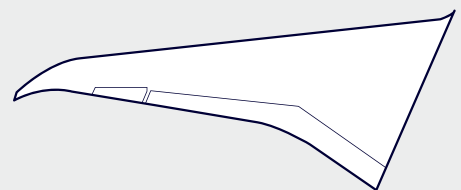
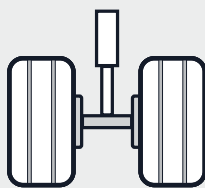
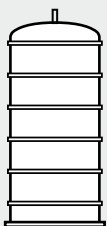


**BTF**   
BUY-TO-FLY





- 6** **WAAM can deliver significant cost savings.**  
It is a cost-effective AM approach for component fabrication<sup>4</sup>. In fact, it is estimated for commercial aviation OEM's that 3D-printed titanium parts could save them up to \$3 million per plane<sup>5</sup>, as titanium swarf is significantly reduced.
- 7** **WAAM can shorten lead times.**  
It replaces long lead-time processes, such as forging and casting. WAAM can cut the time for a large forging from over a year to a matter of weeks for the entire process.
- 8** **WAAM can optimise the manufacturing supply chain.**  
WAAM product development and prototyping can be carried out at WAAM3D's production site, or a team of the company's experts can help the aerospace manufacturer set up their own WAAM system, helping simplify the supply chain.
- 9** **WAAM repairs parts quickly and simply.**  
It can be used to repair holes, cracks, surface marks and notches. It is done either at the point of use, or close by and involves the removal of defects by machining, the deposition of a suitable metal material to fill the groove using WAAM and finishing by machining.
- 10** **WAAM enhances the physical properties of critical components.**  
It can combine multi-material parts, or produce superior strengths by using WAAM3D's patented in-process cold-work solutions to improve the properties of the final component.



# WAAM in practice

## WAAM prototype – a titanium pressure vessel for space exploration.

A team comprising of Thales Alenia Space, WAAM3D, Cranfield University and Glenalmond Technologies has successfully produced a first full-scale prototype of a titanium pressure vessel to be used in future manned missions for space exploration. The vessel is approximately 1 metre in height and 8.5 kg in mass. Made of the titanium alloy Ti-6Al-4V, it has been deposited using the WAAM process.

Lead times have been reduced and the component has used 30 times less raw material than if it was created via traditional processes. By using the WAAM process, more than 200 kg of Ti-6Al-4V has been saved for each item.

## WAAM nose cone.

WAAM3D and Aircraft Research Association Ltd (ARA), Bedford, have partnered to manufacture an aluminium nose cone of diameter 190mm and length 350mm. The component has been successfully integrated into a wind tunnel model ready to be tested in ARA's own Transonic Wind Tunnel. The collaboration is part of a Clean Sky 2 research and innovation funded programme (under GA Agreement no. 864803) to study the benefits of using 'Boundary Layer Ingestion' technology for environmental benefits on future aircraft designs.

The project team optimised the design of the nose cone to make best use of the starting bar feedstock, minimising the material to be deposited, production time, and overall cost. The two organisations, leveraging on decades of experience in their respective fields, were able to compress the often-critical lead time between shape definition to manufactured component and reduced cost with material usage reduced by 74%.



### Sources:

- 1 The buy-to-fly ratio is the ratio of the mass of the starting billet of material to the mass of the final, finished part.
- 2 Allen J (2006) An investigation into the comparative costs of additive manufacture vs. machine from solid for aero engine parts. In: RTO-MP-AVT-139, p 10
- 3 Martina F, Williams S (2015) Wire+arc additive manufacturing vs. traditional machining from solid: a cost comparison. Tech. rep
- 4 John Norrish et al 2021 J. Phys. D: Appl. Phys. 54 473001
- 5 <https://www.theverge.com/2017/4/11/15256008/3d-printed-titanium-parts-boeing-dreamliner-787>

info@waam3d.com  
+44 (0)1234 754693

**WAAM3D.COM**

### WAAM3D Limited

5 Thornton Chase  
Milton Keynes  
MK14 6FD  
United Kingdom

