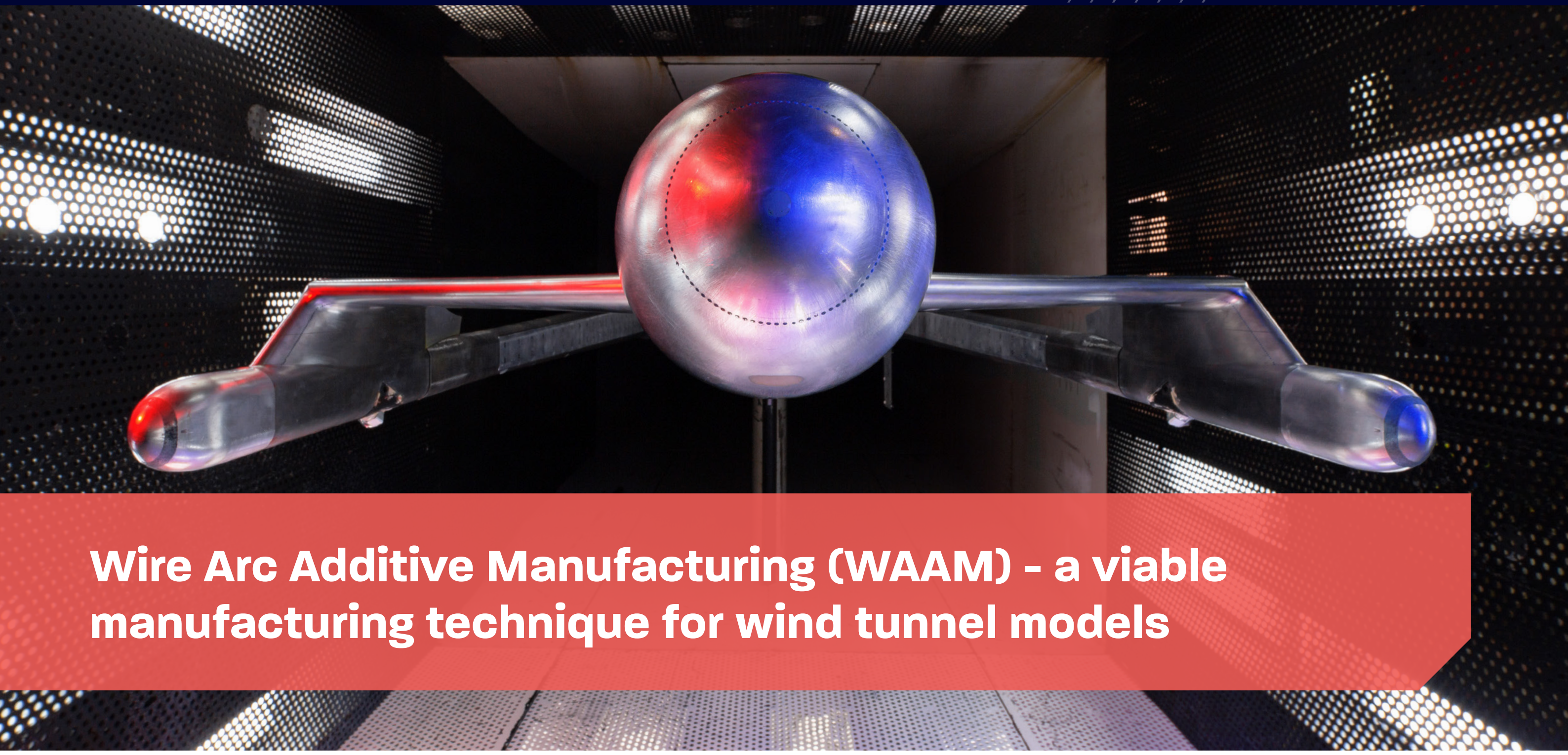
WIRE ARC ADDITIVE MANUFACTURING

CASE STUDY



Wire Arc Additive Manufacturing (WAAM) - a viable manufacturing technique for wind tunnel models

Since the first enclosed wind tunnels became operational back in the 1800's, they have proved their value in aerodynamic investigations and have been a fundamental contributor to every major aircraft programme.

Over recent years, Aircraft Research Association Ltd (ARA) has been looking into ways to improve lead times and costs for model creation and the latest partnership with leading wire arc additive manufacturer WAAM3D has demonstrated the potential of this technology for such projects.

Based in Bedford, ARA has spent many years providing independent research and development to the UK aerospace industry. With a global customer base extending from the west coast of North America, across Europe, to the Far East of Asia, ARA is recognised as a Centre of Excellence in Aerodynamics. Working on many innovative projects for the worlds' major commercial aircraft and defence system manufacturers, ARA is used to pushing the design envelope for technical advantage.

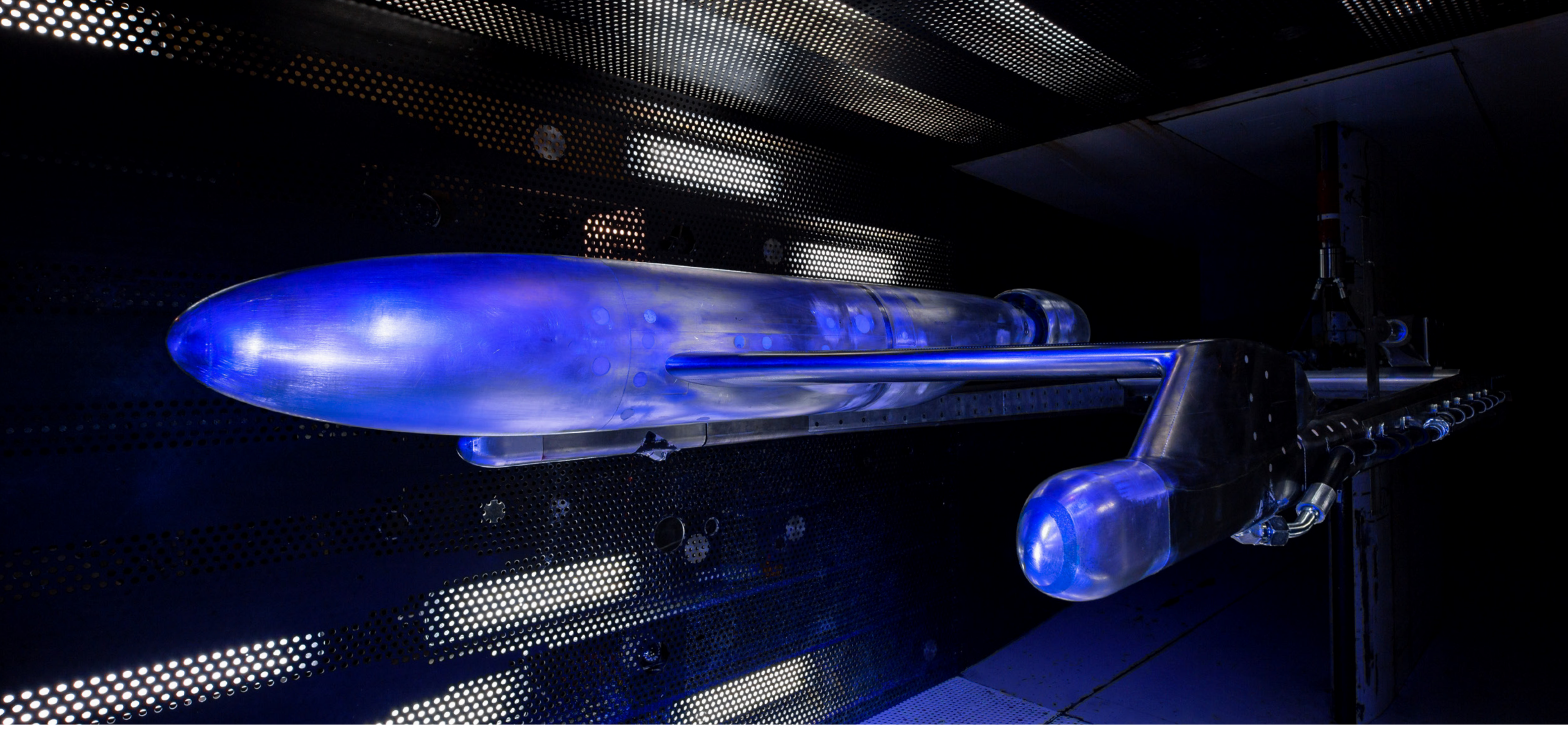
Project information:

ARA

Challenge:
A low-risk way to investigate the WAAM technique to improve lead times, cost and materials savings for wind tunnel model creation and to assess if higher-stress components would benefit from the WAAM production process.

Solution:
Producing a 190 mm diameter and 350 mm length aluminium nose cone using WAAM processes to be integrated into a wind tunnel model as part of a clean Sky 2 research and innovation funded programme.

Learnings & outcomes:
- Reduced material usage by 74% and related environmental benefits
- Potential to reduce cost savings by 5-10% compared to machining from billet in aluminium
- Prototypes can be developed quickly and to defined tolerances
- Significantly reduced lead times for future projects



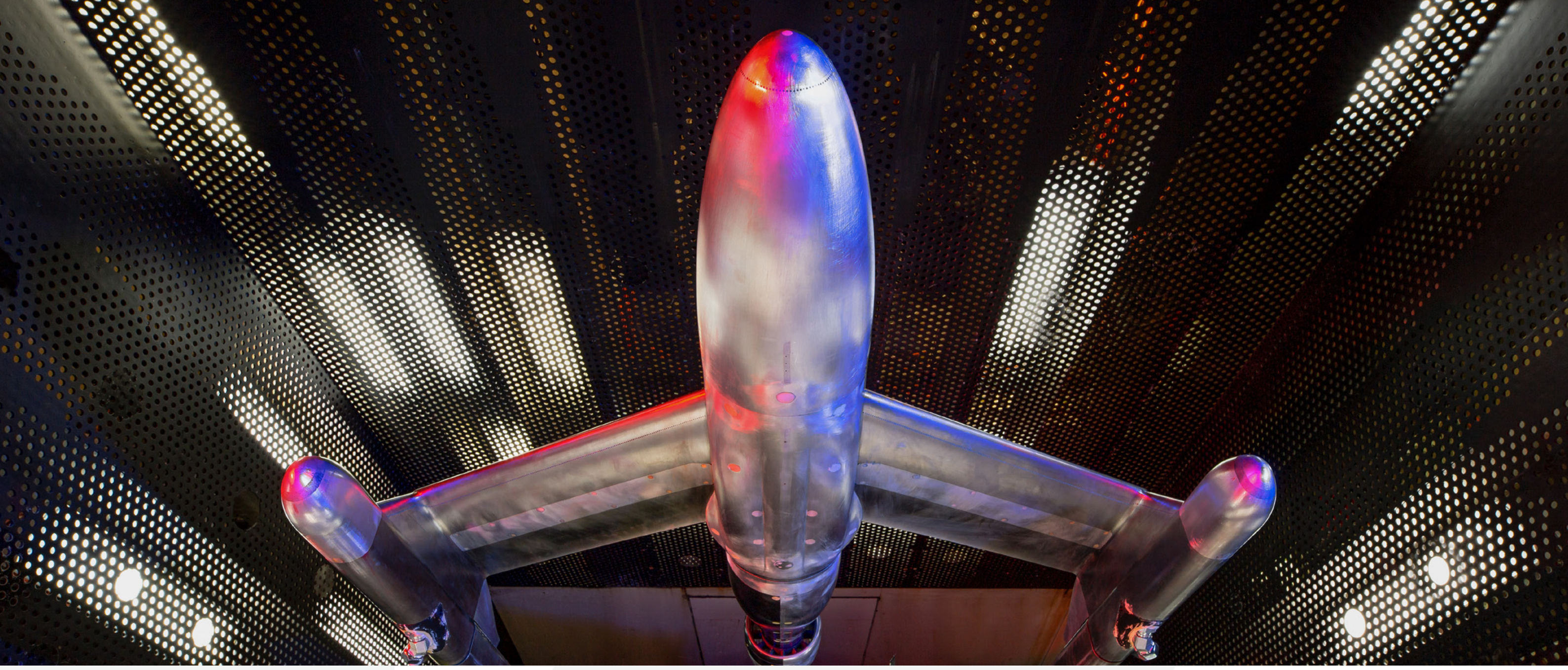
Having previously investigated the potential of a steel wing with the founders of WAAM3D and their team at Cranfield, the aerodynamics engineers at ARA knew that WAAM had the potential to reduce wind tunnel model lead times and costs.

To test this theory, ARA chose a 190mm diameter and 350mm length aluminium nose cone to be produced using the WAAM process that could be integrated into a wind tunnel model as part of a Clean Sky 2 research and innovation funded programme (under GA Agreement no. 864803).

Optimising the design for WAAM

Based on Cranfield University's pioneering research carried out since 2006, WAAM3D is now a leader in large-scale additive manufacturing. Having experience of delivering turnkey solutions based on in-house developed products, services, and materials, the team worked closely with ARA to optimise the design of the nose cone to ensure it delivered in terms of time and cost savings.

Dr Filomeno Martina, CEO and co-founder of WAAM3D, explains further: "We have learned how to fine-tune the WAAM process over the years, to ensure material usage, cost and production times are minimised. For example, on this ARA project, we considered the geometry and made sure that the majority of the starting bar feedstock was built around a vibration damper integrated within the nose cone. This minimised the deposited material, saving time, money, and materials."



Shape definition to manufactured component

The nose cone was made from aluminium 2319 wire feedstock. The near-net shape was produced in WAAM3D's large format 3D metal additive printing platform - RoboWAAM® and was carefully monitored throughout the deposition process by ARA and WAAM3D.

Dr James Alderman, Principal Aerodynamics Engineer at ARA explains further: "We chose to produce a nose cone using WAAM, as we wanted a low risk way to investigate the WAAM technique: a nose cone is a relatively un- stressed part, with a safety factor of around 200. The aim was to see how the process performed in terms of timings, cost, and material savings and to subsequently decide if higher-stress components would benefit from this production process.

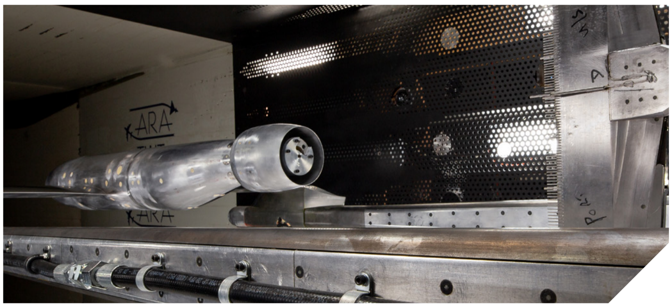
"Once printed, the critical surfaces of the nose cone – those that would be wind swept or interfacing – underwent post machining and inspection at ARA. We set surface profile and finish tolerances of < +- 0.1 mm and Ra < 0.8 microns respectively and these were achieved with ease. Also importantly, there were no issues with any distortion during the machining process."

Fit for purpose

The two organisations, leveraging on decades of experience in their respective fields, were able to reduce material usage by 74% in the aluminium nose cone, which has significant environmental benefits for other projects moving forwards.

Regarding timings and cost, Dr James Alderman comments: "This project was carried out so that we could learn about the process of designing for WAAM and how to post machine it, so we took our time with it. However, we believe that WAAM would deliver around 5-10% cost savings compared to machining from billet in aluminium and would be delivered more quickly now that the learning curve has been shortened. The nose cone produced using WAAM was a success, as it demonstrated the potential benefits of this technique for the manufacture of wind tunnel model components. I see WAAM as a way of shortening our lead times and costs and cutting material waste on other components in the future."

Dr Filomeno Martina concludes: "The nose cone has been successfully integrated into a wind tunnel model that has been tested in ARA's Transonic Wind Tunnel. Through this project with ARA we have been able to demonstrate that prototypes can be developed quickly – and to defined tolerances - using WAAM and perform well under testing conditions."



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