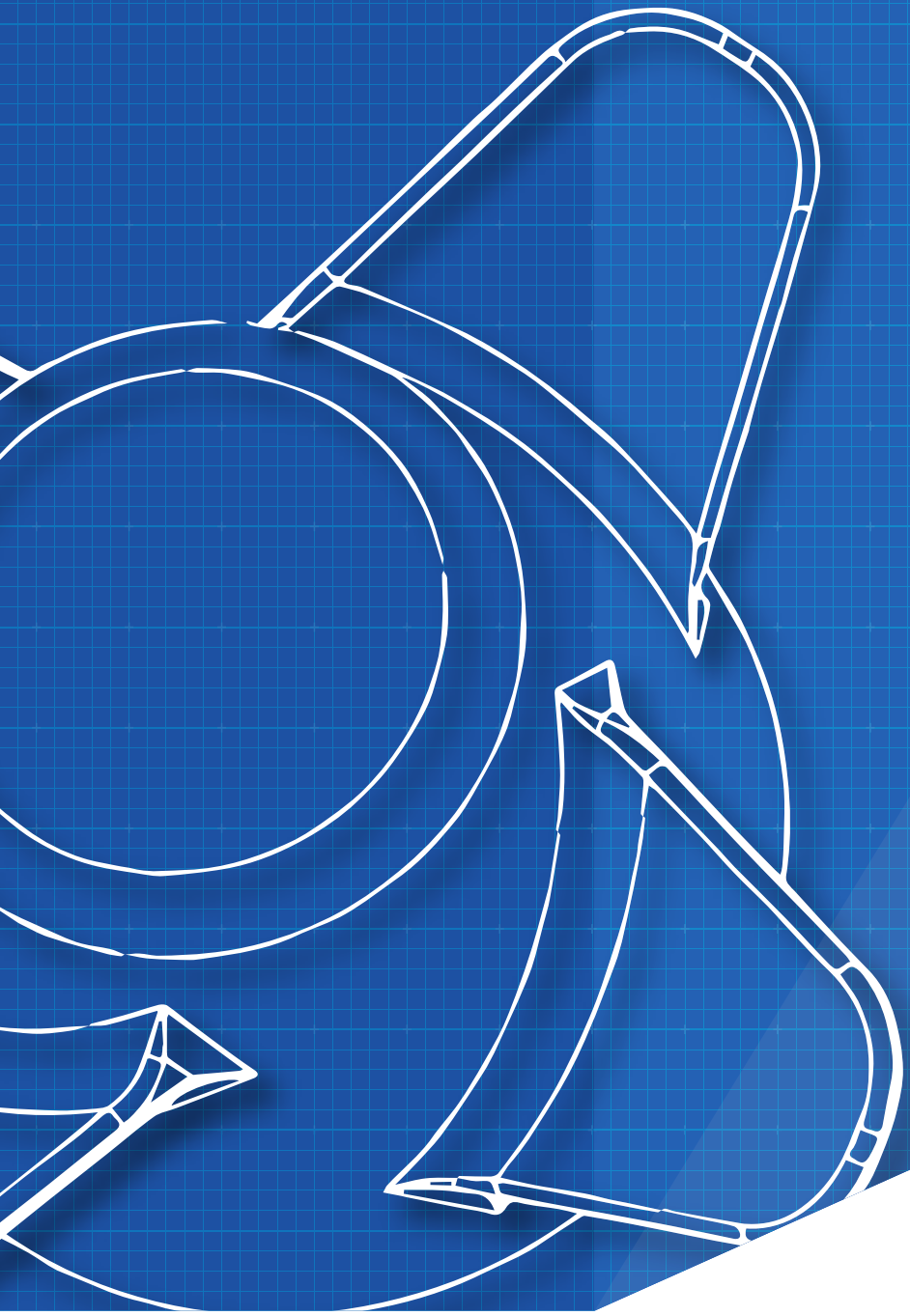
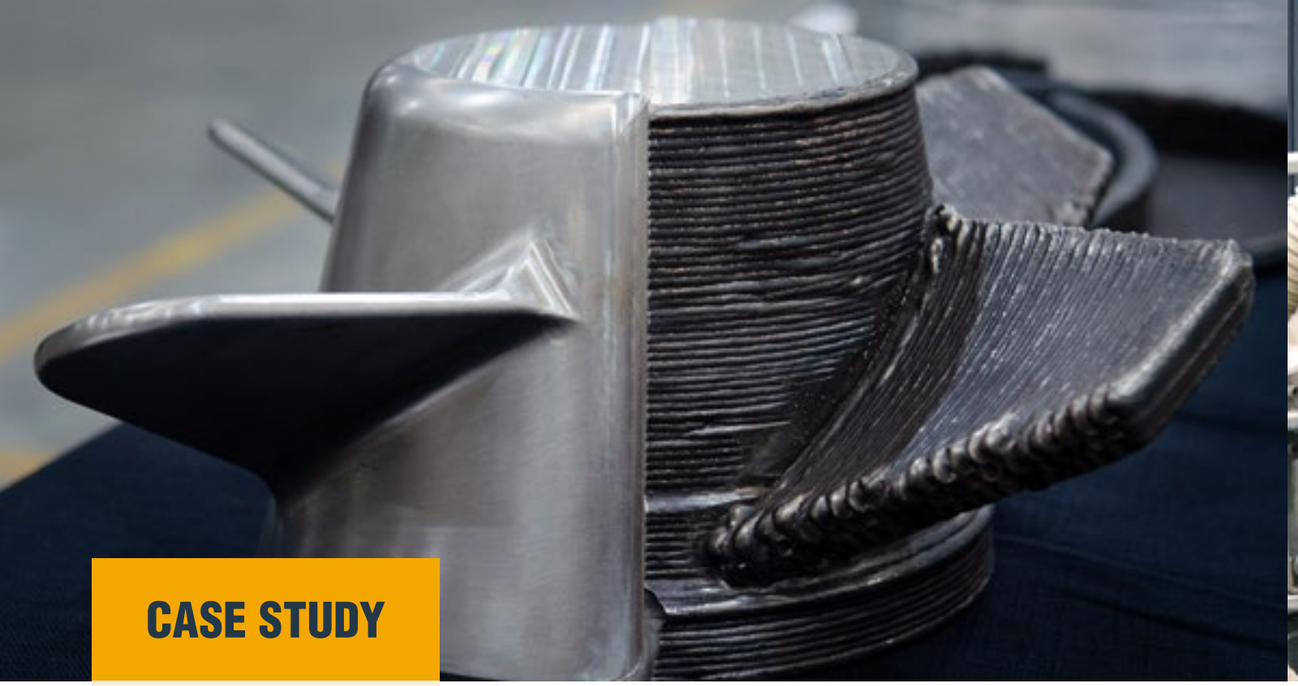
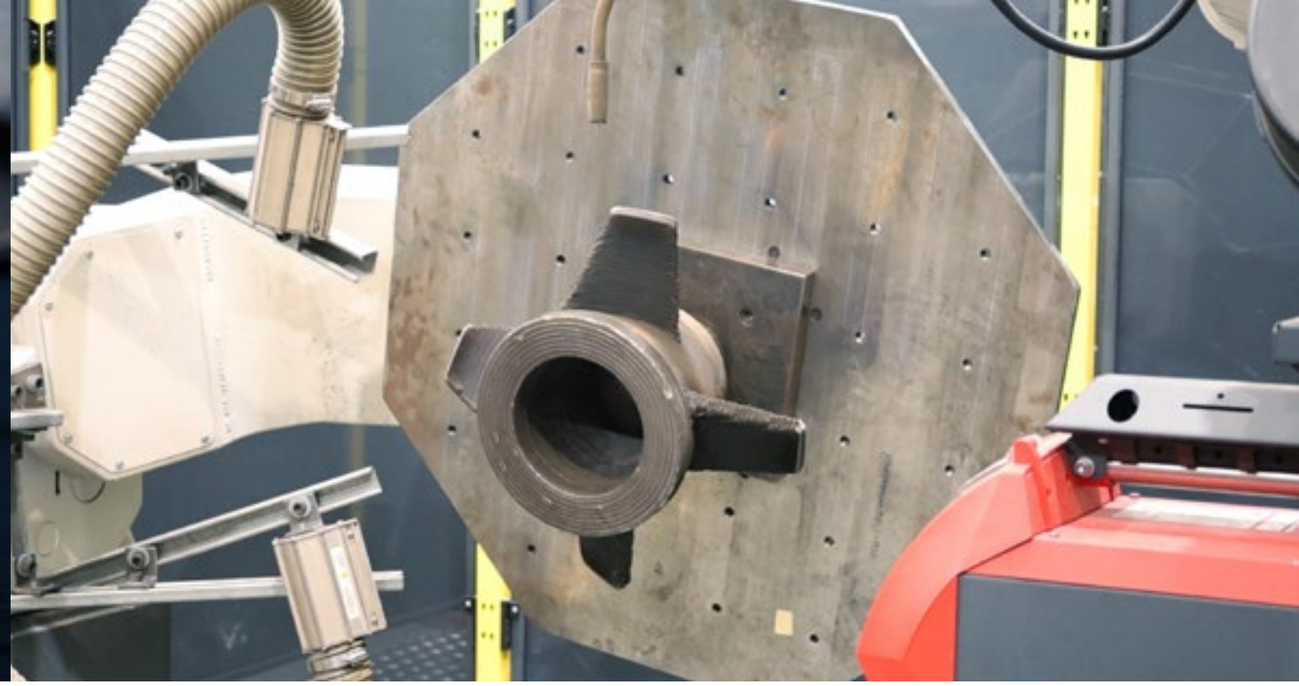
ARCEMY®
CASE STUDY

CAD to Machined Part in 24 Hours: Lower Manufacturing Time while Saving on Material Waste



AML3D®





CASE STUDY

Customer
AML3D

Industry
Manufacturing for Aerospace, Defence, Maritime, Mining, Oil & Gas.

Method
Wire Additive Manufacturing (WAM®)

Material
ER316Lsi

Application
Using its patented WAM® technology, AML3D is disrupting traditional billet machining, forging and casting manufacturing methods.

Advantages

- **Greener –** AML3D's WAM® provides an environmentally sustainable manufacturing solution, reducing material waste compared to billet machining. Additionally, WAM® uses an order of magnitude less energy per kg of printed metal when compared to per kilo of casting produced.
- **Faster –** AML3D offers a faster manufacturing solution when compared to machining billet, forging and casting methods.
- **Stronger –** AML3D's patented WAM® process results in enhanced material properties.

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www.aml3d.com

Background

AML3D Limited, founded in 2014 and a publicly listed technology company since 2020, utilises its new advanced 3D printing technology to pioneer and lead metal additive manufacturing globally. Disrupting the traditional manufacturing space, AML3D has developed and patented a Wire Additive Manufacturing (WAM®) process that metal 3D prints commercial, large-scale parts for Aerospace, Defence, Maritime, Manufacturing, Mining and Oil & Gas.

AML3D has created and patented a Wire Additive Manufacturing (WAM®) process and developed proprietary software, WAMSoft® and AMLSoft™, that drives ARCEMY®, AML3D's industrial metal 3D printer. ARCEMY® provides industry point-of-need additive manufacturing solution that is faster, greener and leaner than conventional manufacturing methods, improving supply chains and enabling metal part suppliers to become globally competitive.

AML3D also provides metal 3D printing design engineering services, software licensing, technical support, consumable sales and contract manufacturing services.

Challenge

"We have been pushing the envelope with Wire Additive Manufacturing to achieve the best results in material properties and waste savings for our customers. Taking our WAM® expertise and applying it within the Industry 4.0 framework, we can provide a certified solution to better manufacture labour-intensive, larger complex parts from a wider range of materials than our peers."

Andy Sales
Executive Director and Chief Technology Officer at AML3D

Supply chains are challenged. Geopolitical uncertainty and the recovery of a post-pandemic world have highlighted the need to improve sovereign manufacturing capability for many nations, resulting in the investigation of alternative manufacturing methods for industry, including those requiring large-scale or exotic metal parts.

Research into Metal Additive Manufacturing, or metal 3D printing, has highlighted several advantages when compared to conventional manufacturing methods such as billet machining, forging and casting. These advantages include the technology being greener and faster than traditional equivalents; however, AML3D has found that these comparisons are largely founded around powder-based additive manufacturing methods and are not always comparable to the WAM® process.

With this in mind, the research and development team at AML3D looked at a selection of critical parts that can be Wire Additively Manufactured that push existing boundaries when producing greener large-scale or exotic material parts faster. Questions around maximising material waste savings while minimising production time prompted Andy Sales, Managing Director and Chief Technology Officer at AML3D, to explore the metal 3D printing of a 316 propeller for the defence and maritime industries.

From CAD to metal 3D printed propeller using AML3D's WAM® is 17 hours. Machining time adds 6 hours to production; you can have a finished piece in under 24!

Solution

Challenging the status quo in manufacturing is AML3D's patented WAM® process. AML3D's WAM® enables engineers and manufacturers alike to access a metal 3D printing solution for large and exotic material parts. 3D printing is generally synonymous with smaller componentry, and until recently, there have been few technologies that can commercially provide a large metal additive manufacturing solution.

AML3D selected a generic hollow barrel and four-blade propeller to manufacture for the demonstrator project. While the piece is smaller in size and Mass than what would be normally fabricated using the Wire Additive Manufacturing process, the payoffs around production time and material waste saving outweighed the normal part qualification process. Additionally, the custom design of the propeller allows engineers to assess WAM® technology with relevance to diameter, pitch, cupping and required edge thickness; aspects of propeller design affect speed, sound and fuel efficiencies.

Furthermore, the propeller was manufactured in the world's first DNV-approved facility for steel, and copper alloy Wire Additive Manufactured parts for shipbuilding. In 2018, AML3D's Adelaide Technology Facility was also the first Wire Additive Manufacturing facility to achieve Lloyd's Register certification. Both DNV and Lloyd's Register approval of manufacture certifications result in class certification of parts for specific industries to be completed through a recognised, verified and certified manufacturing method.

True to common maritime industry materials for manufacture, the propeller was made using a certified ER316LSi wire feedstock; 316LSi features a lower carbon content than generic stainless steel 316, providing improved weldability and corrosion resistance; important features when considering a propellers application for maritime.

Conventional manufacturing would see this propeller made using investment casting or machining from a custom billet block. Both solutions provide pros and cons around lead time and quality. Investment casting may offer a lower-cost solution for smaller quantities; however, repeatability is narrowed, with wax patterns and ceramic moulds having limited life spans. On the other hand, a custom billet may take up to a week to source locally or weeks if sourced internationally. Manufacturing from a billet is repeatable; however, the machining time and material waste to manufacture a 22 kg part are high. Smaller billets could be used to manufacture the barrel and blades with the blades being welded on, though this would increase the potential for corrosion and failure at weld points.

From CAD file to metal 3D printed part using AML3D's WAM® is 17 hours. Machining time adds 6 hours to production; you can have a finished piece in under 24 hours. Compared to the subtractive process from a custom billet, you are looking at a manufacturing process that can be up to 76% faster.

AML3D's 316LSi WAM® Propeller Mass and Production Time

	Mass of Pre-form (kg)	Final Mass (kg)	Build time (hr)
Barrel	40	17	13
Blades	10	5	4
Total	**50**	**22**	**17**

"It excites us that in this WAM® demonstration, we achieved 95 per cent material waste savings at a 75 per cent faster manufacturing rate compared to machining from billet. Combined with greatly improved strength properties compared to casting, WAM® is becoming a viable manufacturing alternative that is greener, faster and stronger than conventional methods."

Andy Sales
Executive Director and Chief Technology Officer at AML3D

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Not only is the manufacturing process faster, but it is also much kinder to the environment. WAM® enables a near-net shape production process, accounting for machining tolerance only where and when required. The traditional subtractive method would see 462 kg of raw material needed to manufacture a 22 kg propeller; compared to the 50 kilograms deposited Mass that makes the WAM® pre-form, we have a material waste saving of 95%.

WAM® 316Lsi Propeller vs Billet Machining

	Billet Machining	AML3D WAM®
Raw material (kg)	462	50
Material Waste (kg)	**440**	**28**
Finished Mass (kg)	22	22
Machining Time (hr)	**97**	**6**

Material waste savings is not the only sustainability feature of using WAM® for part production. The technology also contributes to low-carbon manufacturing. Compared to the typical casting process requiring 2.75 kWh per kg of cast material, WAM® only requires 1.7kWh per kg. While not a gate-to-gate comparison, the energy necessary to manufacture like-for-like at the part manufacture stage strongly indicates lower power consumption per hour per kilogram; lower energy requirements relate to lower greenhouse gas emissions.

Compared to investment casting, WAM® provides the ability to improve material properties. With a range of parameters that can be controlled, such as deposition rates and interpass temperature, independent testing has shown that WAM® improves Ultimate Tensile Strength (UTS). Yield Strength enhancements are also experienced, doubling results from 170 Mpa in casting to over 360 MPa with WAM®.

Lead time, environmental efficiencies and improved material strength aside, AML3D's WAM® provides engineers and manufacturers with the ability to have industrial and exotic material parts made onshore. With more than seven established ARCEMY® production cells at AML3D's certified facility, WAM® technology enables unprecedented flexibility in Australian manufacturing not previously experienced until AML3D's contract manufacturing offering.

AML3D®

Founded in 2014, AML3D is a technology company that is focused on improving manufacturing supply chains by using a proprietary WAM® Process.

AML3D uses new technologies to pioneer and lead metal additive manufacturing globally, enabling our customers to become globally competitive.

We achieve this by combining our patented Wire Additive Manufacturing (WAM®) process with Industry 4.0 capability that is driven by the Industrial Internet of Things (IIoT).

> **The 3D printing of the Panama Chock shows that large components can be made available with shorter lead times and with equal standards of quality and performance.**
>
> *– Aziz Merchant, Keppel Marine & Deepwater Technology*

> **Wire Arc Additive Manufacturing, or WAAM, has the potential to enable a productivity step change in shipbuilding, able to 3D print marine grade metal structures at a scale well beyond other commercially available metal 3D printing technologies.**
>
> *– Andrew Malcolm, Austal*

> **Toolcraft looks to partner with AML3D whenever there is scope for their process – when manufacturing parts larger than commonly available materials or when sourcing exotic metals is cost prohibitive.**
>
> *– Greg Stevens, Toolcraft Australia*

TELL ME MORE

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Australian Patent 2019251514
Japan Patent 7225501