

HEGGEMANN

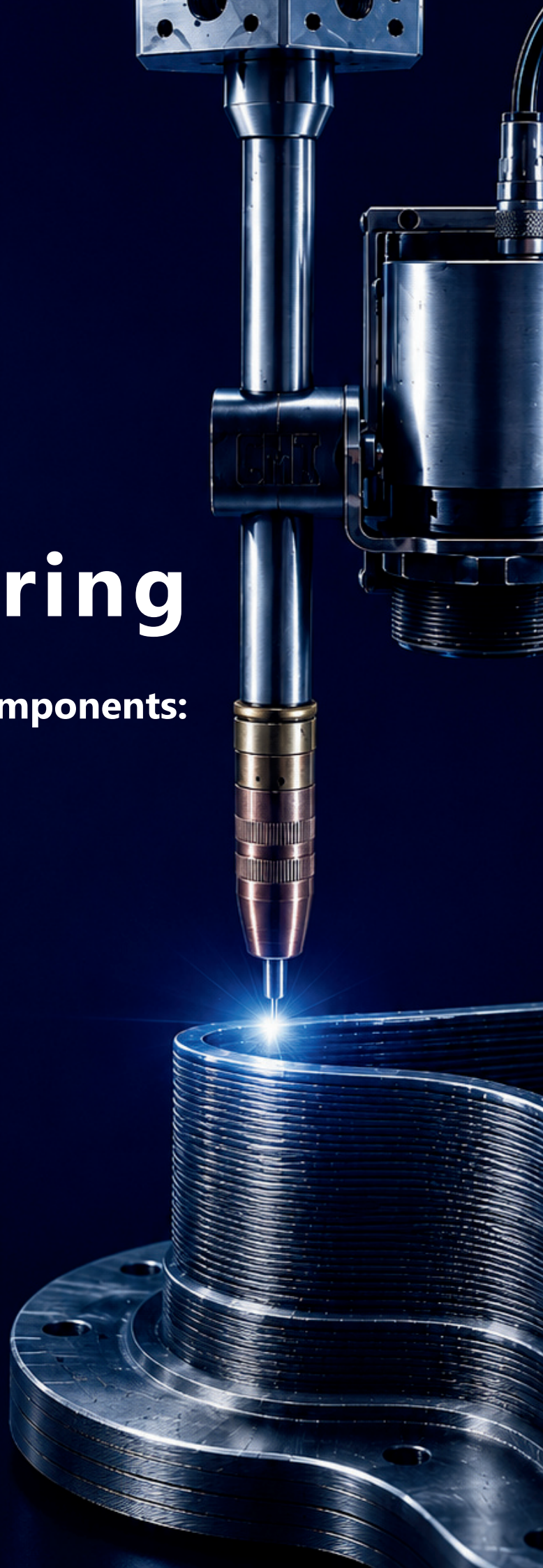


Wire Arc Additive Manufacturing

**A new approach to metal components:
Efficient. Fast. Reliable.**

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Understanding WAAM

In Wire Arc Additive Manufacturing (WAAM), a metal component is not produced by machining from solid material, but is built up layer by layer from a welding filler material.

An electric arc melts the wire, building up the component layer by layer. The resulting structure closely matches the final contour and is then machined to its final dimensions as needed.

The Fronius CMT® (Cold Metal Transfer) technology minimizes the heat input into the component through controlled current and wire feed - which reduces warpage, limits grain growth, and lowers energy consumption.

The result: up to **85% less raw material** required (in a 1:1 comparison to machining from solid), significantly shorter lead times, and a high degree of design freedom - especially for large-volume structural components.

Why wire instead of powder?

Compared to powder-based additive manufacturing processes, WAAM offers not only a significantly higher build rate but also key advantages in terms of handling: Standard welding wires are certified, cost-effective, widely available, and pose no health risks - without the need for time-consuming powder preparation cycles or protective equipment against fine metal dust.



Why WAAM?

The numbers speak for themselves.

WAAM combines elements that rarely come together in manufacturing: speed, material efficiency, cost reduction, and flexibility. With a build rate of up to 2.5 kg/h, WAAM is significantly faster than powder-bed-based processes such as LPBF - and is therefore particularly cost-effective for large-format components.

WAAM vs. CNC Milling: Benchmark comparison

WAAM really shows its strengths compared to machining from solid stock, especially when it comes to large-volume components made of high-cost alloys:

Key figure	CNC Machining from solid material	WAAM
Raw material requirements	100 %	Up to 85 % less
Production time	100 %	Up to 60 % less
Total costs	100 %	Up to 30 % less

The cost-saving potentials shown are based on typical WAAM applications and vary depending on the component geometry, material, and lot size.



Processed materials

WAAM is not limited to a special material. HEGGEMANN has already successfully processed the following alloys:

Material	Class	Typical Applications
Ti-6Al-4V (ERTi-5)	Titanium alloy	Structural components for Aerospace and space application
Inconel 625 (ERNiCrMo-3)	Nickel-based alloy	High-temperature applications in turbine components, offshore, oil and gas, etc.
17-4 PH (ER 630) & 15-5 PH	Precipitation-hardening stainless steel	Structural components for Aerospace and industrial applications
316L (ER316L)	Austenitic stainless steel	Chemical plants, corrosion-prone applications
S355 (ER70S-6)	Unalloyed structural steel	Machine & jig construction
EN AW-5083 (ER5183)	Corrosion-resistant aluminium-magnesium alloy	Shipbuilding, container manufacturing, automotive & rail vehicle manufacturing



From concept to certified component— all from a single source.

Additive manufacturing is more than just a single process step. What matters most is mastering the entire product development chain: from design feasibility analysis and process simulation through the WAAM process to documented acceptance. HEGGEMANN handles this entire chain in-house.

Concept & planning



- Constraint and feasibility analysis
- Design-for-WAAM consulting & topology optimization
- Sustainability assessment and cost estimation
- Specification development / advanced quality planning — even if no standard exists yet



Process development & optimization

- Track design
- Thermomechanical simulation (deformation, residual stresses, temperature profiles)
- Component-specific in-house fixture development



Production

- WAAM Process with fronius CMT® technology
- Active process control using sensors for quality monitoring
- Heat and surface treatment



Qualification & Acceptance

- 3D scanning and digital comparison with specifications
- In-house material characterization (non-destructive and destructive testing)
- In-house process and personnel qualification in accordance with aerospace standards



Documentation

- Full traceability of all process data
- Digital product passport & inspection plans
- Flexible data archiving & export formats

Technical competence in detail

In WAAM, process control begins long before the first weld is made. The thermal complexity of the process requires metallurgical expertise - and tools that translate that expertise into reproducible processes.

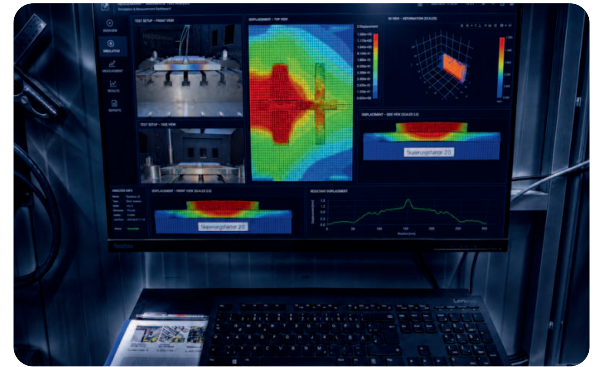
Thermomechanical simulation

Every weld bead laid affects the temperature history of the underlying layers. This can lead to uncontrolled warpage, residual stresses, and undesirable microstructural changes. Using FE-based process simulation, we calculate temperature profiles, warpage, and residual stresses before the first weld bead is laid - and use these calculations to determine optimized welding paths, cooling times, and clamping conditions.



In-house process monitoring

Using thermography, we measure the actual heat input into the component during the process. The thermal data validate our simulation and enables reproducible temperature control - a crucial factor for achieving homogeneous microstructures and reliable mechanical properties.



Material expertise

Each alloy reacts differently to the thermal cycles of the WAAM process. Depending on the material class, phenomena such as phase transformations, hot cracking, or undesirable microstructural changes may occur, thereby significantly affecting the mechanical properties of the component. We understand this behavior and specifically take this into account when designing the process controls and heat treatment.

We perform destructive and non-destructive testing either in-house or in collaboration with our long-standing partners.

In-house fixture development

We develop and manufacture custom clamping fixtures entirely in-house - from engineering to production. This enables quick response times and optimal conditions for the WAAM process. Since fixtures can directly influence the thermal behavior of the component, we take thermal interactions between the component and the fixture into account right from the design phase.



Quality & certification

As a Nadcap™-certified company, we had already established appropriate quality assurance procedures and guidelines for our additive manufacturing process even before the publication of specific WAAM standards. For applications without an existing standard, we work with you to develop a customized testing and qualification strategy.

Certifications & accreditations

- EN 9001
- EN 9100
- ISO 3834
- DIN 2303
- Nadcap™ AC 7110/4
- Nadcap™ AC 7110/5
- Nadcap™ AC 7110/12

WAAM-related standards & guidelines

- AMS 7005
- AMS 7010
- DIN 17024-2
- ISO/ASTM 52943-2
- Nadcap™ AC 7131
- CM-S-008
- DNV-ST-B203

Our Digital Product Passport provides a complete record of every step in the manufacturing process. This includes, among other things, process parameters, test results, and material certificates. This is how we ensure the quality, reproducibility, and cost-effectiveness of your components - even when faced with the most demanding requirements.

proWAAM — The complete solution for cost-efficient WAAM manufacturing

Many WAAM projects fail not because of the process itself, but because of isolated approaches: track planning without process knowledge, systems without a qualification strategy, and certification without a manufacturing partner. proWAAM bridges this gap.

The partnership combines the complementary strengths of HEGGEMANN, ModuleWorks, and Heidenbluth - three specialists who collectively cover the entire WAAM value chain.

HEGEMANN

Process & quality

Thermomechanical
Simulation, Process-Reliable
Manufacturing, Certification

ModuleWorks

Toolpath planning

Automated Toolpath
Planning &
Simulation

Heidenbluth

Equipment & operations

Custom-designed
equipment, training, and
maintenance

Your benefits with proWAAM

- Cost reduction through efficient, simulation-based processes and reduced material scrap
- Time savings through automated toolpath planning and parallel thermo-mechanically coupled process simulation
- Shorter qualification times through shared resources and coordinated systems
- Customized WAAM systems, including commissioning, training, and ongoing support
- Flexibility to meet individual customer requirements (from prototypes to series production)

Through our partner network, we are continuously expanding our portfolio - for future-proof WAAM solutions that grow with your needs.



Why HEGGEMANN?

WAAM requires more than just a robot and a welding filler material. It requires a deep understanding of the process, metallurgical expertise, and a quality system that meets the demands of challenging industries. That has been our commitment for over 60 years.

Welding expertise



At its core, WAAM is a welding process. What others still need to develop, we already have: over 60 years of experience in welding technology and the qualification of complex processes - the foundation for consistent, reproducible results.



Complete in-house process chain

Simulation, fixture design, manufacturing, heat treatment, testing, and documentation - all under one roof and seamlessly coordinated. This enables short turnaround times without any loss of efficiency at the interfaces.



Thermomechanical simulation

We perform calculations before we weld. By simulating the thermal history within the component, we identify and eliminate process risks early on and can specifically optimize temperature profiles - as well as the resulting changes in microstructure and properties - before the first layer of material is applied.



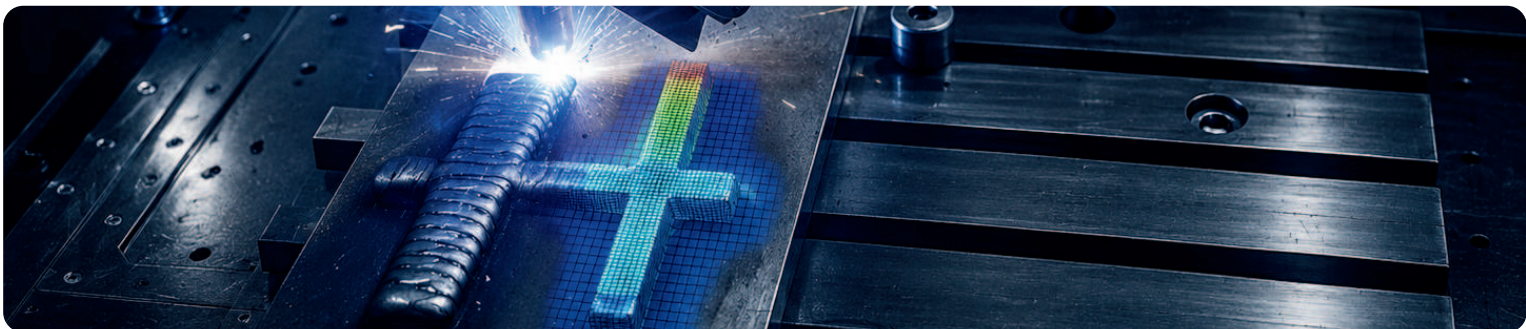
Materials expertise for thermally complex processes

Titanium, Inconel, aluminium, or high-strength steels: We understand how these materials behave under WAAM conditions and use this knowledge specifically for process control.



NADCAP certification & industry experience

Our quality systems are designed to meet the highest standards in the aerospace industry and are directly applicable to other demanding industries.



HEGGEMANN



Ready for take off with **HEGGEMANN?**

**Talk to us -
together, we'll analyse whether
and how WAAM can help
advance your manufacturing
operations.**

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