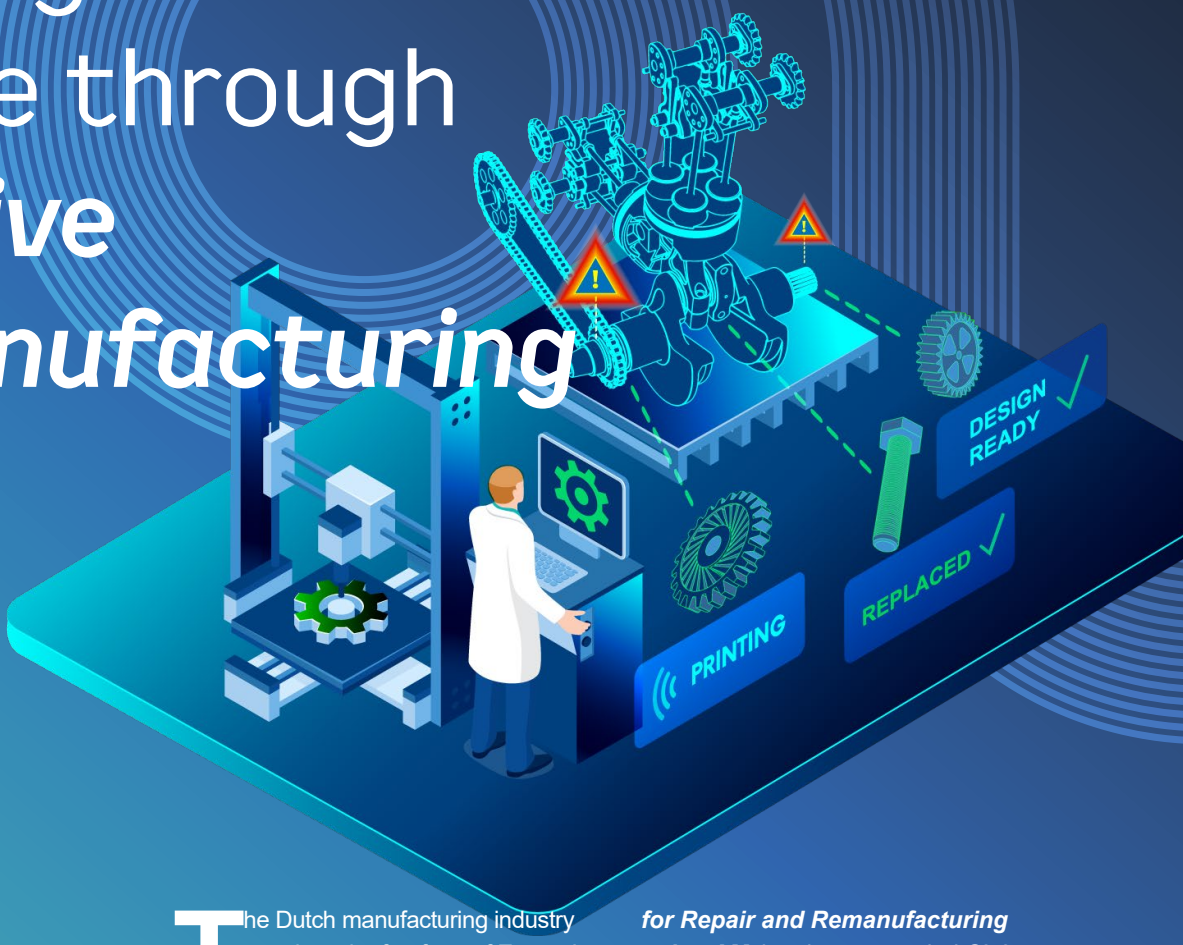
Add-reAM

Building a Circular Future through *Additive Remanufacturing*



The Dutch manufacturing industry stands at the forefront of Europe's transition toward a circular economy. Yet the sector still faces a critical challenge: how to move from a linear model of "make, use, discard" to one that keeps materials and products in use for as long as possible. A new national research and innovation initiative, Add-reAM, aims to provide the answer.

Add-reAM, which stands for ***Advancing the Dutch Circular Economy through Additive Manufacturing: Strategies for Repair and Remanufacturing using AM***, has been awarded €6.8 million under the Dutch Research Agenda (NWA-ORC 2024) programme. Led by Professor Ian Gibson of the University of Twente, in collaboration with the Materials Innovation Institute (M2i), the project brings together the country's leading universities and major industrial partners. These include SKF, Signify, RAMLAB, Capgemini Engineering, Repair Cafe and Allseas, working alongside municipalities and knowledge institutes.

Their shared mission is clear: to make repair the new standard and remanufacturing the driving force of a sustainable, circular manufacturing industry.

From Linear to Circular Production

Traditional manufacturing processes, even when supported by advanced recycling systems, are often wasteful. Valuable materials, embedded energy and technological know-how are lost when products reach the end of their first life. Recycling can recover part of this value, but often through downcycling, where materials and components lose quality and usefulness.

Add-reAM offers a different approach. By using Additive Manufacturing (AM), also known as 3D printing, components can be rebuilt, upgraded and reused instead of discarded. AM enables rapid, localised production of spare parts and opens new possibilities for repair and remanufacturing across sectors such as aerospace, rail, and heavy machinery.

The consortium's targets are ambitious but measurable. Add-reAM aims to reduce production waste by 30 percent, cut maintenance downtime by 20 percent, and lower CO_2 emissions and e-waste by 20 percent. These figures demonstrate not only the environmental benefits but also the operational and financial value of embracing circular production.

"Additive manufacturing allows us to rethink the way we create and maintain products," says Professor Gibson. "Instead of designing for obsolescence, we can design for longevity. By integrating repair and remanufacturing into production systems, we reduce waste and strengthen industrial resilience."

Technology Meets Intelligence

Additive Manufacturing is already well established in prototyping and specialised production. What Add-reAM seeks to do is scale it up and integrate it into mainstream industrial operations. To achieve this, the project combines advanced 3D printing techniques with artificial intelligence and digital quality monitoring.

AI-supported tools will help manufacturers make data-driven decisions about when and how to repair components. They will be able to predict wear and failure, recommend optimal repair strategies and ensure that remanufactured parts meet or exceed original performance standards.

At the same time, design guidelines for 3D-printable spare parts will help companies standardise digital inventories and simplify logistics. This will enable decentralised and on-demand production, reducing the need for large warehouses filled with rarely used components.

For companies operating in high-value sectors such as aerospace or maritime engineering, where downtime costs are high and part availability is critical, the combination of AM and AI offers a significant competitive edge.

A Business Case for Sustainability

Circular manufacturing is often perceived as a sustainability initiative, but Add-reAM positions it firmly as a business opportunity. The Netherlands' manufacturing sector employs more than 600,000 people and adds around €47 billion to the economy each year. Yet it remains highly resource intensive.

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By rethinking production processes, companies can cut costs, improve efficiency and enhance their resilience to global supply chain disruptions.

Additive Manufacturing enables production to take place closer to where it is needed. Spare parts can be produced locally, often within hours rather than weeks, reducing logistics costs and dependency on international suppliers. For large industrial players, this opens the door to new service-based business models, where the focus shifts from selling new components to extending the lifetime of existing ones.

Small and medium-sized enterprises also stand to benefit. AM technologies are becoming more accessible and affordable, allowing SMEs to offer niche repair and remanufacturing services that were previously out of reach. By combining local production with digital design and data analytics, they can participate in new circular value chains that reward quality, flexibility and innovation.

Aligning People, Policy and Practice

Technology alone cannot deliver the circular transition. Add-reAM recognises that policy frameworks, education and social acceptance must evolve in parallel.

The consortium will work with industry associations, public agencies and academic institutions to help develop the knowledge and regulatory clarity required for large-scale adoption of AM-based repair and remanufacturing. Clear standards and certification procedures will be crucial to build confidence among both manufacturers and consumers.

Equally important is education. Universities and technical institutes will use insights from Add-reAM to develop training programmes that equip engineers, designers and technicians with the skills needed for Industry 5.0. This will ensure a workforce that understands not only how to produce efficiently, but also how to design for longevity and circularity from the outset.

A cultural shift is needed in how businesses and consumers perceive remanufactured products. Research within the project will examine how product design, communication and customer experience can increase trust in repaired and remanufactured goods. By demonstrating that such products can meet high performance standards, the project aims to remove one of the last psychological barriers to circular consumption.

Collaboration for Impact

The scale of the Add-reAM consortium reflects the magnitude of the task. It brings together expertise from materials science, production engineering, logistics, environmental assessment, behavioural science and law. Industrial partners contribute real-world challenges and test environments, ensuring that research results are directly applicable in practice.

The project will demonstrate the benefits of AM-based repair and remanufacturing through pilot cases

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in sectors including aerospace, construction and rail infrastructure. By showing how these technologies work in real industrial contexts, Add-reAM will provide a foundation for broader adoption across the manufacturing landscape.

Beyond technical innovation, the initiative also strengthens collaboration between academia, industry and policymakers. This integrated approach is essential to achieving the long-term ambition of a circular, climate-neutral Dutch economy by 2050.

Remanufacturing for Growth and Good

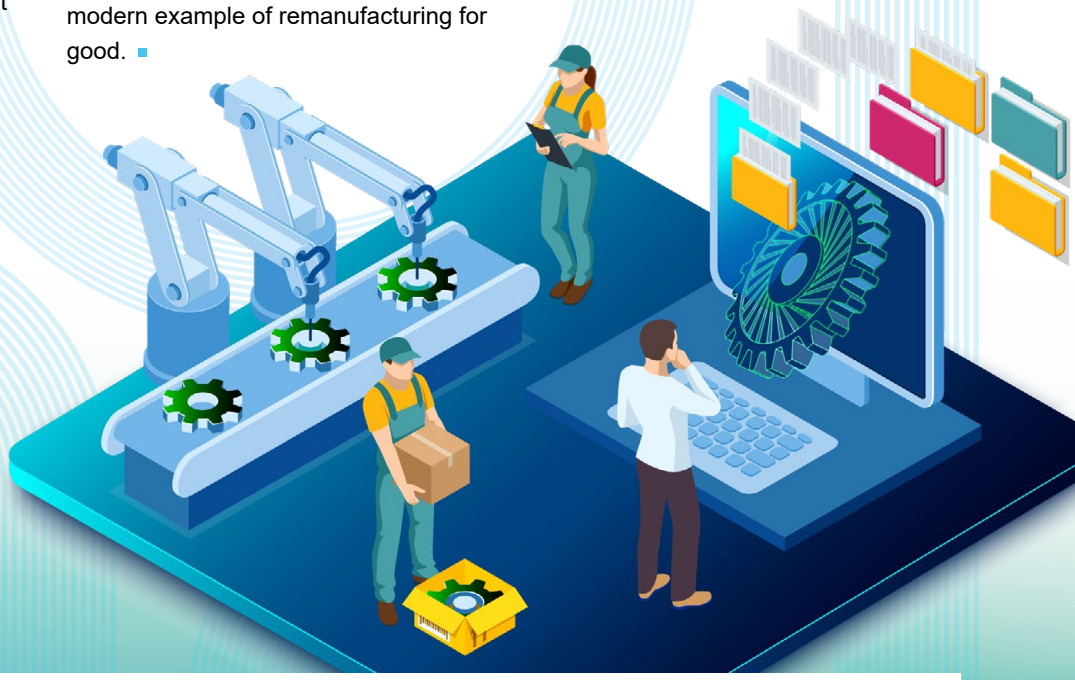
The vision behind Add-reAM goes beyond environmental responsibility. It represents a new economic paradigm where waste is eliminated, resources are kept in circulation and value is created through longevity rather than volume.

For business leaders in the high-tech manufacturing sector, this project signals a future where circularity and competitiveness go hand in hand.

By combining digital technologies with sustainable design, Dutch industry can enhance its global position while meeting urgent climate goals.

As Professor Gibson summarises, “Add-reAM is not just about developing new tools or processes. It is about changing the mindset of manufacturing. When repair becomes part of the business model and remanufacturing becomes a strategic capability, sustainability becomes a strength rather than a cost.”

In the years ahead, the success of Add-reAM will be measured not only by the technologies it develops, but by the way it reshapes industrial practice. It offers a compelling vision for how additive manufacturing can support both prosperity and the planet — a truly modern example of remanufacturing for good. ■



Add-reAM Academic Partners

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