Repairing crankshafts with technology-assisted laser cladding: oil&gas user case

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1. Introduction / Strategic Context

Europe’s industrial sector is facing a critical transformation. Achieving climate neutrality by 2050 demands both technological innovation and systemic change toward circularity, where products and materials remain in use for as long as possible. In this context, remanufacturing—the process of restoring used components to like-new condition—plays a strategic role. It reduces dependency on raw materials, mitigates emissions, and enhances industrial resilience.

The R3-MYDAS project, funded under Horizon Europe, contributes directly to these goals by developing a multi-actor framework that merges advanced mechatronics, digital intelligence, and sustainability-by-design approaches. Its mission is to deliver new methods and tools for remanufacturing, repurposing, and recycling energy-sector components, including Oil & Gas crankshafts, electric vehicle batteries, and wind turbine gearboxes.

For TMCOMAS, a company with more than 60 years of experience in mechanical repairs and surface engineering, this initiative represents a unique opportunity to push the boundaries of industrial remanufacturing. As the leader of WP2’s Oil & Gas demo case, TMCOMAS is pioneering the digital transformation of laser cladding—a core process in component repair—by aligning it with Europe’s Green Deal, Circular Economy Action Plan, and Industry 5.0 vision of sustainable, human-centric innovation.

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2. Technological Development Overview

At the heart of TMCOMAS’s contribution lies the automation of the laser cladding process through advanced sensing, modelling, and robotic integration. Laser cladding is a technique that deposits metallic powder onto worn surfaces, restoring their geometry and mechanical performance. While this process is widely recognized for its precision and durability, it traditionally relies on manual robot programming and operator expertise, limiting efficiency and repeatability.

Under R3-MYDAS, TMCOMAS is developing a digital workflow that elevates this process to a new level of intelligence and autonomy:

3D Scanning and Point Cloud Generation – Damaged crankshaft areas are scanned using a snapshot camera and laser high-resolution 3D scanning system. The resulting point cloud is processed through AIMEN’s proprietary software to reconstruct the full geometry with sub-millimeter accuracy.

Automated CAD and Path Planning – The cleaned and meshed point cloud serves as input for automatic robot path generation, taking into account tool accessibility, collision avoidance, and optimal cladding parameters.

Virtual Cell and Digital Twin – The complete process is tested in a simulated environment where trajectories, cladding head tilt angles, and thermal profiles are validated before implementation on the shop floor.

The novelty of this system lies in its end-to-end digital integration. Each step—from scanning to validation—is connected through a shared data architecture, enabling traceability, repeatability, and adaptability to different part geometries. The Technology Readiness Level (TRL) of the solution is currently 5–6, with full pilot testing planned for 2026 at TMCOMAS facilities in Girona, Spain.

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3. Problem or Gap Addressed

In the current As-Is scenario, TMCOMAS's laser cladding operations are highly efficient but largely manual. Each repair requires a new robot program tailored to the unique geometry of the crankshaft. This manual programming can take several hours per component, depending on its complexity, and introduces variability due to human factors.

Additionally, the absence of geometrical data capture limits traceability and hinders the creation of digital records for quality assurance. The result is a process that, while reliable, is time-intensive and difficult to scale.

From an environmental perspective, traditional practices often lead to the scrapping of worn components rather than repairing them, generating unnecessary material waste and CO_2 emissions. Replacing a single industrial crankshaft can consume hundreds of kilograms of raw steel and several megawatt-hours of energy.

The challenge, therefore, is twofold:

To automate and digitalize the process without compromising quality or operator oversight; and

To quantify and optimize the environmental and economic impact of remanufacturing compared to replacement.

These are precisely the gaps that TMCOMAS and R3-MYDAS are addressing through their collaborative research and technological development.

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4. Position Statement

At TMCOMAS, we believe that the future of remanufacturing depends on the fusion of human expertise with digital intelligence. Automation is not about replacing skilled technicians, it is about empowering them with better tools for decision-making, monitoring, and process control.

Our position within R3-MYDAS is clear: laser cladding, enhanced by digitalisation, represents a cornerstone technology for sustainable industrial repair. By embedding 3D vision, dedicated software, and virtual simulation into the workflow, we are enabling:

60% reduction in programming time through automatic path generation.

Up to 30% reduction in rework due to consistent geometry and process repeatability.

Substantial sustainability benefits, including reduced material use, lower energy consumption, and decreased CO_2 emissions.

These results demonstrate that remanufacturing can be both technologically advanced and environmentally responsible. Moreover, the new digital framework positions TMCOMAS as a reference in smart repair solutions for critical energy assets, strengthening Europe's competitiveness in high-value manufacturing.

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5. Opportunities and Impact

Industrial and Economic Opportunities

The digital workflow developed by TMCOMAS has immediate applicability across multiple industrial domains beyond Oil & Gas, including power generation, aerospace, and heavy machinery. Any sector reliant on high-value metallic components can benefit from automated remanufacturing processes that reduce downtime and extend component lifespan.

Economically, the advantages are clear: reduced repair times lead to lower labour costs, while digital repeatability ensures consistent output quality. For SMEs, this model also enables the creation of new remanufacturing business lines that are less dependent on manual expertise and more resilient to labour shortages.

Environmental and Societal Impact

From an environmental standpoint, the benefits are significant. Early Life Cycle Assessment (LCA) results suggest that digitalized remanufacturing could cut up to 70% of raw material usage and 50% of energy consumption compared with conventional replacement. Each repaired crankshaft represents a tangible reduction in industrial waste and embodied carbon.

Socially, the shift toward digital tools transforms the operator's role from manual executor to process supervisor and problem-solver. This upskill contributes to Industry 5.0's human-centric vision, where technology augments human creativity rather than replacing it.

Alignment with European Policy Priorities

The TMCOMAS use case directly contributes to the objectives of the European Green Deal, Circular Economy Action Plan, and Sustainable Products Initiative, supporting a resource-efficient and low-emission industrial model.

Furthermore, it aligns with Industry 5.0, which emphasizes sustainability, resilience, and human-centric innovation as key drivers of Europe's technological leadership.

Through its integration of mechatronics, digitalization, and sustainability assessment, the R3-MYDAS framework exemplifies how EU-funded innovation can translate policy ambitions into tangible industrial solutions.

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6. Conclusion

The R3-MYDAS project represents a pivotal step toward redefining how Europe remanufactures its critical industrial assets. For TMCOMAS, participation in this initiative is both a technological and strategic milestone.

By combining our industrial experience in laser cladding with the digital intelligence developed in collaboration with AIMEN, ZIKNES, and other partners, we are demonstrating that sustainable remanufacturing is not only feasible but also competitive and scalable.

As Europe accelerates its path toward climate neutrality, TMCOMAS remains committed to advancing the next generation of smart, circular, and human-centric manufacturing solutions.

"Our mission is to bridge the gap between traditional craftsmanship and digital innovation. By doing so, we are not only restoring components—we are restoring value, trust, and sustainability to European industry."

Dr. Jaume Nin, TMCOMAS – WP2 Use Case Leader