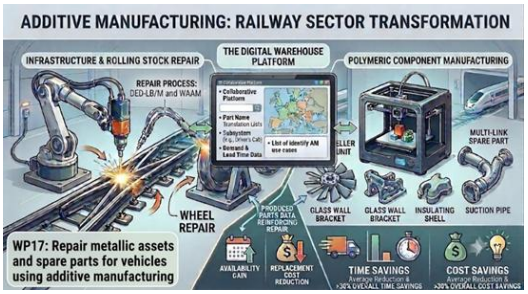
# Additive Manufacturing:

# Railway Sector Transformation




Work package 17 (WP17) focuses on the application of Additive Manufacturing (AM) to transform railway maintenance by improving the repair of critical metallic assets, such as rails, turnout crossings and wheels, and enabling the production of spare parts on demand, supported by digital tools. The results achieved so far demonstrate strong potential to extend component lifetime, reduce maintenance costs and increase the efficiency and resilience of railway systems.

A key area of work within WP17 is the repair of railway infrastructure components, which are traditionally maintained through labour-intensive and low-automation processes. In this context, two complementary approaches have been developed for rail and turnout repair. On the one hand, an automated system (Use case (UC) 17.1) integrates surface scanning, material removal, Laser Beam Directed Energy Deposition using metallic powder deposition (DED-LB/Mp), and final machining into a fully controlled process, significantly improving repeatability, accuracy and overall repair quality. In addition, this use case includes the development of new repair materials specifically designed for additive manufacturing, exhibiting superior wear resistance compared to conventional materials, further enhancing the durability and performance of the repaired components.



Automated in-situ rail repair using DED-LB/Mp (UC17.1)

On the other hand, a portable, manual solution (UC17.3), based on Laser Beam Directed Energy Deposition using metallic wire deposition technology (DED-LB/Mw), enables in-situ repair under

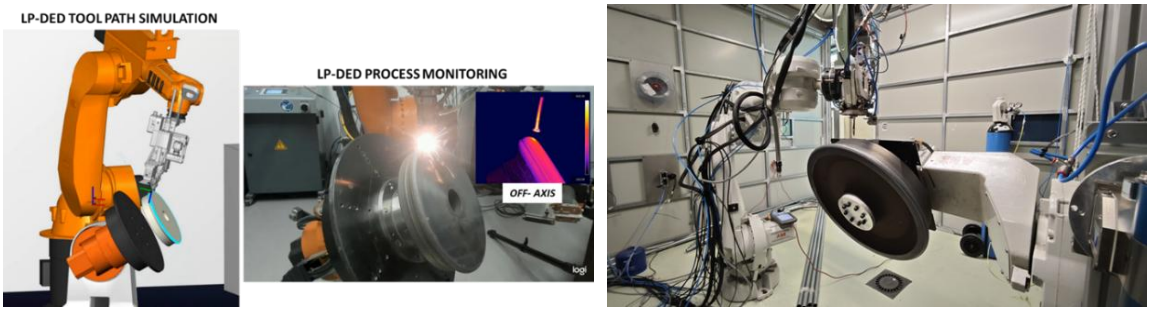
The project is supported by the Europe's Rail Joint Undertaking and its members.

real operational conditions. While not automated, this approach offers high flexibility, reduced thermal impact compared to conventional welding and improved process control and safety. Together, these solutions are expected to enable a service life extension of up to 25%.



Portable AM (wire-based Laser DED) solution for in-situ rail repair (UC17.3)

Additive Manufacturing is also being applied to the repair of railway wheels (UC17.2), one of the most critical and costly components in rolling stock. Using DED-LB/Mp-w technologies in both powder and wire formats, WP17 has successfully demonstrated the repair of two full-scale wheels. Validation activities, including wheel–rail contact simulations, indicate that a service life extension of around 25% can be achieved, while avoiding complex and costly disassembly operations.




AM repair machine for wheels: (left) wire-based L-DED technology and (right) powder-based L-DED technology (UC17.2)

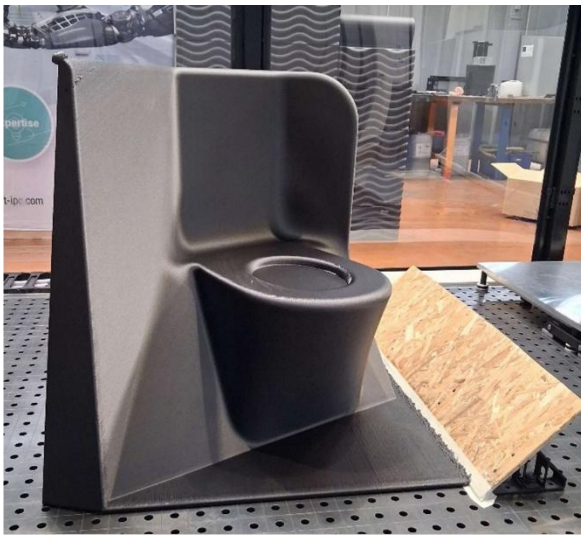
For more complex components such as turnout crossings, a workshop-based Wire Arc Additive Manufacturing (WAAM) solution (UC17.4) has been developed. This approach allows the targeted deposition of tailored materials adapted to local stress conditions, improving wear resistance and fatigue performance. Laboratory results indicate an average service life extension of over 34%, with significantly improved performance under specific conditions. However, these results should be considered indicative, as further validation under real operational conditions is required.

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Stationary solution for AM repaired turnout crossings using WAAM technology (UC17.4)

In parallel, WP17 explores the use of Additive Manufacturing to produce polymer spare parts (UC17.5), particularly large interior components that must comply with strict fire safety standards (EN 45545). Several demonstrators have been developed, including a door cover already installed and tested, as well as components currently under development for passenger applications. These solutions have demonstrated up to 80% reduction in lead time and approximately 50% reduction in costs. In addition, new flame-retardant materials have been successfully qualified, expanding the material portfolio for railway applications.

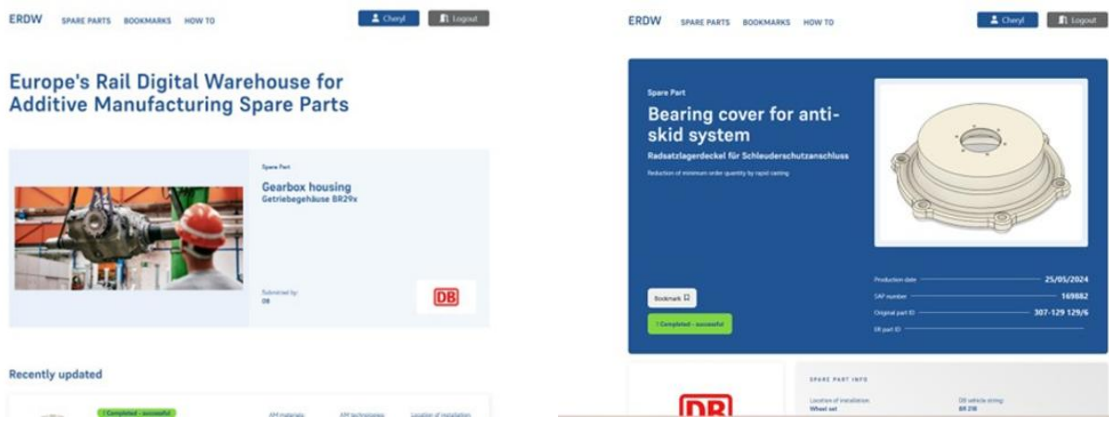




Toilet cover from SNCF and door cover from ÖBB, manufactured by 3D printing (UC17.5)

To support the deployment of these technologies, WP17 has developed a Digital Warehouse platform (UC17.6), enabling railway operators to identify suitable spare parts for AM production, share use cases and standardise methodologies. This collaborative approach reduces duplication of effort and enables more efficient decision-making. Results show average reductions of 75% in lead time and 63% in costs for the analysed use cases.

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Digital Warehouse platform for AM Spare parts (UC17.6)

Overall, WP17 highlights the strong potential of Additive Manufacturing to improve railway maintenance, from enhancing repair quality and extending asset lifetime to enabling faster and more flexible spare part production. At the same time, several challenges remain, including the need for further industrialisation, integration with legacy systems and improved availability of technical data.

Future work will focus on validating the developed solutions under real operational conditions and further expanding their application. These efforts will contribute to advancing the adoption of Additive Manufacturing as a key enabler of more efficient, sustainable, and resilient railway systems.

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