



HARMONICA

HARMONICA Brings a Human-centred Approach to Advanced Recycling Manufacturing

Lisbon, September 2026 - HARMONICA - Human-Machine Knowledge, Skills, and Dexterity Hybrid Augmentation in Advanced Recycling Manufacturing - has launched a three-year initiative to reshape how people and advanced technologies work together in recycling environments. Coordinated by Queen's University Belfast, the project brings together 15 partners from nine European countries to develop human-centred physical and cognitive augmentation solutions that support workers in dynamic and hazardous industrial settings.



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Recycling plays a central role in Europe's transition towards a circular economy, helping to recover valuable materials, reduce dependence on virgin resources and support more sustainable industrial value chains. However, many recycling processes remain highly dependent on manual work due to the dexterity, flexibility and decision-making required to handle complex and unpredictable materials.

This places workers at risk of exposure to hazardous substances, dust and biological agents, as well as injuries associated with heavy machinery, repetitive movements and physically demanding tasks. Although automation and digital technologies can help address some of these challenges, existing solutions often focus primarily on machine performance and may struggle to adapt to the variability of real recycling environments and the different needs and capabilities of workers.





HARMONICA addresses this gap by placing people at the heart of technological development. Workers, managers and social partners will help design and evaluate solutions that respond to operational needs and promote safety, autonomy, trust and inclusion.

Combining multimodal sensing, photonics and human-centred AI, the project will provide workers and systems with better awareness of shop-floor conditions. Semi-autonomous mobile manipulators will assist with dangerous and physically demanding activities, allowing workers to focus on tasks requiring human judgement, expertise and supervision.

A key component will be the Psychological-Physical Digital Twin (Psy-PhyTwin), which will combine data on workers' physical and cognitive states with information from machines and their environments to support more adaptive human-machine collaboration. Adaptive human-machine interfaces and mixed-reality learning environments will provide context-aware guidance, training and continuous skills development, while ensuring human oversight and transparent, explainable and controllable technologies.

The solutions will be evaluated in three industrial living labs focused on electric vehicle battery pack recycling, rare earth magnet recycling, and mixed industrial and municipal waste recycling. These trials will assess technical performance, safety, usability, trust, inclusiveness and industrial relevance under realistic conditions.

HARMONICA is coordinated by Queen's University Belfast and brings together a consortium of 15 partners from nine European countries:



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