R3 Robotics

Knorr-Bremse Circular Technology Award

R3 Robotics, April, 2026

Pitch Video: https://we.tl/t-WRsuhAPFvJVkeFMA

Images: https://we.tl/t-cU5jEQftA3pxcO4C

Proof of Concept

1. Introduction

R3 Robotics proposes a structured four-month proof-of-concept to demonstrate automated disassembly of brake discs at our certified recycling facility in Karlsruhe. Built on a proven system originally developed for EV battery pack disassembly, a hazardous and mechanically variable disassembly challenges in any industrial context, R3 brings the vision technology, robotic cell infrastructure, and process expertise to unlock automated end-of-life processing for complex industrial components at scale.

This PoC is designed to produce three outputs: a validated automated disassembly process for Knorr-Bremse brake disc variants, a quantified circular value case for material recovery over shredding, and a joint blueprint for what industrial disassembly at scale looks like, commercially modelled under R3's Robotics-as-a-Service offering.

2. PoC Structure Suggestion in 10 Phases:

1. **Product Scoping & Batch Definition** — July

Define specific brake disc variants in scope, axle-mounted and/or wheel-mounted, and agree on a representative batch of 50–100 end-of-life units sourced from Knorr-Bremse's return or depot streams. Document the range of disc sizes, bolting configurations, and wear states present in the batch. Variability across units is the primary challenge this PoC is designed to address.

2. **Teardown Analysis & Material Mapping** — July

Conduct structured manual teardowns to map the full component anatomy: disc body (cast iron / steel alloy), friction ring, mounting bolts, and intermediate elements such as vibration-damping inserts. Identify material composition per sub-element, flag any hazardous content (friction material compounds, lubricant residues), and produce the disassembly sequence that drives robotic cell logic.

3. **AI Vision & Detection Model Training** — July – August

   Train R3's vision system on brake disc geometry, bolt pattern recognition, and surface condition classification. Drawing on models already validated for EV battery pack disassembly, the system is adapted to robustly detect bolt head location and torque resistance indicators across the full range of wear and corrosion states present in real field-condition units.

4. **Robotic Cell Configuration & Tooling** — August

   Configure the disassembly cell for the mechanical demands of rail brake discs: heavy part handling, high-torque bolt removal, and secure clamping during unscrewing operations. Select or fabricate appropriate end-effectors and fixtures, and integrate torque sensing to handle seized or corroded fasteners without damaging the recoverable disc body.

5. **Safety & Process Compliance Validation** — August

   Validate handling procedures for friction material dust (respirable particle containment), heavy part manipulation, and surface treatment residues. Establish a compliant dust extraction and containment setup within R3's certified facility before any processing runs begin.

6. **Supervised Pilot Runs — Learning Phase** — September

   Process an initial batch of 20–30 discs under human oversight, using each cycle to refine bolt removal sequencing, grip force parameters, and friction ring separation steps. Log all failure modes, stripped bolts, unexpected corrosion, part slippage, and feed corrections back into the system iteratively. Track cycle time, success rate, and intervention frequency from the first unit.

7. **Sustained Autonomous Run** — Optimisation Phase — September – October

   Process the remaining batch with reduced operator intervention, targeting a stable automated cycle time and a component separation yield above 90% by weight. The disc body (cast iron / steel), friction material, and fasteners should exit as distinct, uncontaminated material streams ready for downstream processing.

8. **Material Recovery & Circular Value Quantification** — October

   Weigh and characterise each recovered stream. Quantify recoverable tonnes per input tonne and map against current scrap market values and Knorr-Bremse's disposal costs. If friction material contains recoverable metal content (sintered copper-based pads), quantify that stream separately. This builds the economic case for why automated disassembly outperforms shredding as an end-of-life route.

9. **Benchmarking Against Manual Disassembly** — October

   Run a structured time-and-cost comparison against manual dismantling of the same disc type. Demonstrate R3's advantage in throughput, consistency, and material purity, the three dimensions where automation creates the clearest value over manual labour at scale.

10. **Final Report & Scale-Up Scenario** — October

    Deliver a joint PoC report covering technical results, circular value potential, and a forward-looking deployment scenario: volumes, throughput rates, and integration with Knorr-Bremse's existing reverse logistics and end-of-life operations. Include a commercial model outline for scaling under R3's Robotics-as-a-Service offering.

Facility

All PoC work will be conducted at R3 Robotics' certified recycling and disassembly facility in Karlsruhe, Germany. The facility is equipped with the robotic cell infrastructure, safety containment systems, and material handling capabilities required for this scope. Knorr-Bremse is invited to observe supervised pilot runs in person.

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