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## Advanced Joining Technologies

increased reliability, longer lifetime and less maintenance

## Use of Advanced Rail Steel Grades

will become easier and more cost effective for rail operators

## Reliability

technologies will provide less disruptions and a higher safety level

## Ecology

environmentally friendly and energy efficient joining techniques

## Coordinator

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## Partners

University of Huddersfield – Inspiring tomorrow's professionals
TU Delft – Delft University of Technology
ProRail
Goldschmidt Thermit Group
DENYS
jackweld
CHALMERS
ID²
ARTTIC – International Management Services

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# Innovative Welding Processes for New Rail Infrastructure

# WRIST

**WRIST** is developing flexible and cost effective joining processes for rail products and in particular for the more recently introduced bainitic rail steel grades, for which currently available conventional welding techniques have shown to be inadequate.

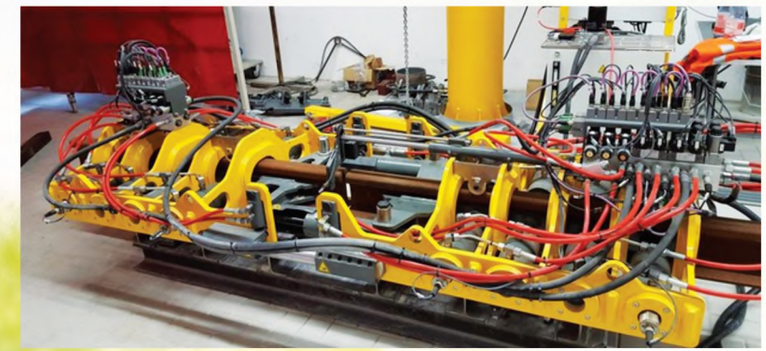
The project offers a step change in the joint performance and reliability, providing an extended in-service life for a range of rail materials, which are facing increasing demands due to the increasing speed and growth of railway's load. This will be delivered by the combined development of the joining processes itself, computational modelling, material and joint characterisation and testing, both on small-scale laboratory tests and full scale trials.

**WRIST** is developing two innovative methods for joining rails, automatic forged aluminothermic welding and orbital friction welding, which will both reduce the width of the Heat Affected Zone (HAZ) and minimise the loss of mechanical properties in the weld zone.

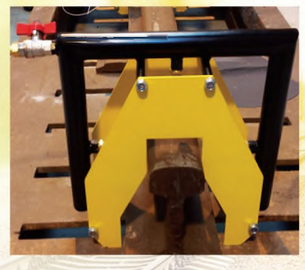
## Automatic forged aluminothermic welding

In the domain of aluminothermic welding WRIST is developing four new technologies and processes. The main development is a prototype for applying controlled compressive forces during the welding process. The prototype consists of a metallic, highly rigid supporting skeleton, a hydraulic unit for generating the necessary drive and pressing forces as well as a sensor system for controlling the process. With this unit, relative geometric alignment of the rail ends to each other can be achieved, as well as the introduction of direct pressure forces for compression or forging of the weld joint and the shearing of excess weld material.

Based on its uses (**AL**igning, **FO**rging and **S**hearing) this equipment has been nicknamed **ALFONS**.



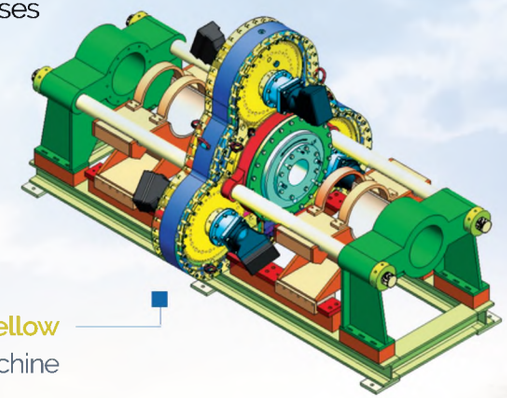
The second development is a process and machine control system that collates all the incoming data from the welding process and generates and documents the manual inputs of the operator, the specified process parameters and the measured values from sensors during the sequence of the automated process steps.



Finally, for use after the welding process has taken place, an enhanced cooling system and a weld finishing tool have been developed. The cooling system brings several benefits to welding teams in the field as it helps to create a geometrically stable joint enabling accurate profile grinding and allows for the ability to complete final weld inspection within a welding shift. The weld finishing tool is a machine that ensures the contours and surfaces are restored following the alumina-thermic welding process to comply with standards, and the accelerated cooling of the welded joint.

## Orbital friction welding

**WRIST** is developing a new and innovative orbital friction welding method. This will be using the existing FRIEX welding system from the industrial partner Denys, and will be capable of generating orbital friction welds with a high degree of reproducibility. The FRIEX welding concept uses rotary friction for the welding of large pipes using an intermediate part. Within WRIST an orbital motion mechanism has been designed to be incorporated into the FRIEX machine. This is nearing completion and soon will be installed and tested.



The WRIST mechanism - blue & yellow incorporated into the FRIEX machine

The major challenge has been to apply the orbital process at a large industrial scale, requiring practically every aspect and component to be researched and designed from first principles, to ensure the machinery will perform as required. This challenge faced by the design and build of the WRIST mechanism has been a lot larger than originally envisaged. As well as the mechanism itself a substantial gearbox and hydraulic system have had to be designed, manufactured and integrated with the orbital friction mechanism. This has caused some delays with the testing of the machine on bars and rails, which will now start in June 2017 instead of November 2016.

As can be seen from the two photographs, which show the gearbox and the corresponding cover, the scale of this undertaking has increased hugely since the initial designs were proposed.