about [the project]

STWIN aims to develop an **advanced friction stir welding (FSW) method** capable of producing complex 3D structures for a variety of steel grades and thicknesses.

Simultaneously, the project will explore the advantages of combining the FSW process with real-time quality monitoring systems to move towards zero-defect manufacturing. To achieve this, the integration of **AI** and smart **digital twin** technologies will be optimised.

The potential of STWIN's approach will be validated by **3 use cases**: (1) complex 3D joint assemblies; (2) joints involving dissimilar materials and (3) joints with dissimilar thicknesses.



AI-powered improvement in the steel stir welding process

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This project is funded by the European Union through the Research Fund for Coal and Steel (RFCS) under Grant Agreement No. 101112504.

FSW

AI-POWERED IMPROVEMENT



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Advanced, non-destructive technologies to improve steel stir welding process through AI and smart digital twin



Flawless welds powered by *real-time quality control & Artificial Intelligence*

STWIN aims to joint high-strength steels using friction stir welding — even across *dissimilar materials and thicknesses*

The *Challenge*

The metalworking and welding sectors are facing significant structural and economic challenges. Recent crises —including the pandemic and inflation— have reduced productivity, while an ageing workforce and a shortage of skilled welders threaten the long-term sustainability of the industry.

At the same time, limited adoption of advanced technologies is hindering innovation, reducing competitiveness and making it more difficult to attract and retain talent.

STWIN responds to this threefold challenge by promoting technological advancement, strengthening workforce development and reducing environmental impact.



OBJ1. Real-Time Quality Monitoring for FSW

Within STWIN, a novel real-time monitoring system will be developed and demonstrated. The system will integrate key process parameters with complementary data obtained through a combination of sensors.

OBJ2. Development of AI models and a Digital Twin

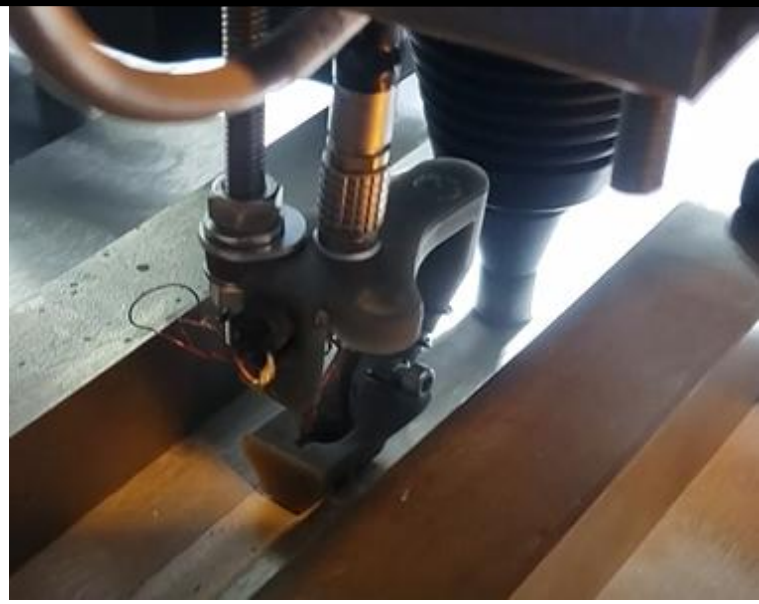
STWIN will develop a digital twin for friction stir welding (FSW), supported by Machine Learning models. This framework will enable real-time process analysis, predictive capabilities and data-driven optimisation.

OBJ3. Manufacturing Process Optimisation

STWIN will evaluate and further enhance FSW tools for steel welding applications. New tool geometries will be designed and assessed to optimise joint performance, mechanical properties and tool lifespan.

OBJ4. Demonstration and Industrial Validation

To validate the developed methodology at industrial scale, STWIN includes a strong demonstration component comprising three case studies: (i) joining of high-strength steels for crane applications, (ii) welding of complex geometries and dissimilar materials for the automotive sector and (iii) joining of aluminium to steel for trailer applications.



PROJECT MISSION

STWIN will accelerate the digital transition of the metal manufacturing industry. Through automated sensor data analysis supported by AI, the project will enable immediate adjustments to the FSW process and early defect detection.

PROJECT VISION

STWIN will strengthen industrial competitiveness by demonstrating its solutions in demanding manufacturing sectors. At the same time, increased automation will contribute to more attractive working environments, supporting workforce upskilling.