SAFERAIL

Development of Novel Inspection Systems for Railway Wheelsets

Funding: European (7th RTD Framework Programme)
Duration: Oct 2008 - Sep 2011
Status: Complete with results
Total project cost: €4,448,701
EU contribution: €3,000,000

Call for proposal: FP7-SST-2007-RTD-1
CORDIS RCN: 89883

Background & policy context:

The contribution of the rail industry to the economic growth of the EU Member States is widely acknowledged. At the time of this project, the European rail industry started showing signs of recovery after a long period of steady decline. The technological advances in train design during the last few decades have led to the manufacturing of faster and more comfortable trains making rail transport a more attractive option for passengers in comparison to other means of transportation. The need for the society to employ greener transportation policies is expected to further enhance the role of rail transport in the global economy.

Nowadays rail networks across Europe are getting busier with trains travelling at higher speeds, carrying more passengers and heavier axle loads than ever before. The combination of these factors has put considerable pressure on the existing infrastructure, leading to increased demands in inspection and maintenance of rail assets. The expenditure for inspection and maintenance has thus, grown steadily over the last few years without however being followed by a significant improvement of the industry's safety records. A large proportion of all equipment related accidents in the rail industry is due to failed train wheels and axles.

The continuous increase in train operating speeds means that catastrophic failure of a wheel or axle may result in very serious derailments, such as the one that took place in Eschede, Germany in 1998, causing loss of life, injuries, severe disruption in the operation of the network, damage to the tracks, unnecessary costs, and loss of confidence in rail transport by the general public. SAFERAIL seeks to minimise wheelset failures by developing and successfully implementing a novel on-line system for the inspection of wheels and axles of moving trains, and a combined ultrasonic-electromagnetic system for faster and more reliable inspection of the quality of new and old wheelsets during their production and maintenance.

Objectives:

The project's technical objectives were:

- To overcome the limitations of existing inspection methodologies during wheel set production and maintenance by developing a combined ultrasonic phased array - ACFM inspection system with capability of automatically analysing the defects detected.
- To develop novel ultrasonic phased arrays for detection of deep buried defects in wheel sets during production and maintenance.
- To develop novel ACFM sensors for detection of surface-breaking defects on wheel sets during production and maintenance.
- To develop novel software that will enable the automated operation of the UT-ACFM system.

Methodology:

Recently, the rail industry has shown a strong demand for the development of on-line techniques for
Recently, the rail industry has shown a strong demand for the development of on-line techniques for reliably monitoring the condition of wheel sets of moving rolling stock. It has also sought for improvements and advancements in the existing inspection methodologies of wheel sets during their production and maintenance. The European Commission has also set new safety targets and stricter procedures for the rail industry as part of the plan for reform and integration of national member-state rail networks in a Pan-European single network. Safety aspects of rail transport have been particularly highlighted by the EU rail directives in an effort to increase public confidence in train travel. Successful implementation of the reform plan for the rail industry will allow significant economic and environmental benefits to be achieved by the society.

The SAFERAIL project supported the effort of the rail industry to achieve better safety standards by developing novel methodologies and techniques for the inspection of wheel sets. The present project will minimise wheel set failures and damage caused by faulty wheel sets to the rail tracks and rolling stock by:

- Developing an on-line inspection system, that will be placed at pre-chosen strategic points on the rail network tracks, for inspection of faults in wheels and axles of passing trains. The system will be able to inspect passing trains for flats in the wheels, defective wheel set bearings, significant cracks and wheel profile abnormalities. The system will use an identification system for each passing train, and each wheel set will be given an identification code. If a fault is identified on a wheel set in one of the passing trains by the SAFERAIL system, then the system will automatically alert the signalling engineers who will then decide what action to take for that particular train, i.e. advise maintenance, reduce speed or stop it completely. In the case of a severe defect being discovered, the system will permit the signalling engineers to stop a particular train immediately in order to carry out emergency maintenance.
- Developing a novel inspection system of new and wheel sets in service based on ultrasonic phased arrays and ACFM probes. The consortium of this project will develop a novel ultrasonic phased array system, with higher resolution and speed of inspection operation, coupled with novel ACFM probes for the identification of surface breaking faults. Currently, ultrasonic phased arrays and other techniques in use to inspect.

**Parent Programmes:**

*FP7-TRANSPORT - Transport (Including Aeronautics) - Horizontal activities for implementation of the transport programme (TPT)*

**Institute type:** Public institution

**Institute name:** The European Commission

**Funding type:** Public (EU)

**Lead Organisation:**

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<td><strong>Address:</strong> Granta Park Great Abington Cambridge CB1 6AL United Kingdom</td>
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<td><strong>EU Contribution:</strong> €675,000</td>
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**Partner Organisations:**

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<th>Vtg Rail Uk Ltd</th>
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<tr>
<td><strong>Address:</strong> Berkely Business Park, Wainwright Road 4A Worcester WR4 9FA United Kingdom</td>
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Technical Software Consultants Ltd

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EU Contribution: €253,750

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Portugal

Organisation Website:
http://www.isq.pt

EU Contribution: €384,882

Feldman Enterprises Limited

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1105 Nicosia
Cyprus

Organisation Website:
http://www.fev.com

EU Contribution: €169,150

Technologies:
Non destructive testing
Novel ultrasonic phased arrays for detection of defects in wheel sets

Development phase: Research/Invention

Key Results:

Trackside Monitoring
The HFVA and AE trackside inspection systems have been developed independently but have been designed in such a way to interface with existing rail infrastructure. In the picture shown below the setup at EMEF is shown. A beacon exchanges data with passing trains and searches in a database for fitted bogies and wheel set. Then, on request, wheel set data becomes available for AE post-processing, referencing critical key performance indexes (KPIs). At the main EMEF depot rolling stock bogie and wheel set inspection data is conveyed to a database, and made available for correlation in such a manner that, for damage episodes in a bogie/wheel set, historical data can be analysed/correlated for pattern identification.

ACFM manual inspection system
A working prototype alternating current field measurement ACFM manual inspection system has been developed. The manual Inspection ACFM probes comprise two newly developed probes for the inspection of axles and wheels respectively. The wheel probe has been designed to inspect the surface of the wheel that comes into contact with the rail. As the wheel is worn down, the profile of the wheel changes. To accommodate for this change in profile, the individual sensor coils are mounted in spring loaded pistons, that can move up and down independently. The wheel probe consists of twenty channels with three sensor coils each (one for each orthogonal direction). It also contains orthogonal field generation coils, allowing it to detect and accurately size surface breaking defects in any orientation. This sophisticated design is the most complex probe TSC have designed, and represents a step-change in their technology. Previous probes of this complexity have been created, but have not had either the twin excitation field or the design for the complex shaped profile - they have been created for flat steel plates.
Phased array ultrasonic test (PAUT) manual inspection system
A working prototype phased array ultrasonic test (PAUT) manual inspection system has been developed. The manual inspection PAUT system design comprises a number of inspection techniques and probe designs specific to the inspection area of the wheel set. Of-the-shelf PAUT data acquisition modules were used, and the value added by the SAFERAL project was in the development of the inspection techniques and unique deployment of the PAUT probes. Probe holders including encoders have been developed and offer reliable inspection solutions for both axle.

Strategy targets
An efficient and integrated mobility system:

- Secure transport
- Acting on transport safety

Innovating for the future (technology and behaviour):

- A European Transport Research and Innovation Policy

Documents:
- SafeRail: magazine VTG Online [Summer 2010] (Other relevant documents)
- Final Report Summary - SAFERAL (Development of Novel Inspection Systems for Railway Wheelsets)

STRIA Roadmaps: Vehicle design and manufacturing
Transport mode: Rail transport
Transport sectors: Passenger transport, Freight transport
Transport policies: Safety/Security, Digitalisation
Geo-spatial type: Other