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ANNUAL REPORT 2013

JVTC at Luleå University of Technology
LULEÅ RAILWAY RESEARCH CENTER

Table of content

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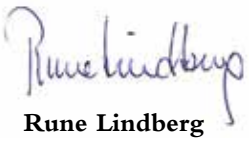
Chairman´s Message

The objective of research is twofold. One: to create new knowledge and better understanding of fundamental issues. Two: to develop intelligent persons to become capable problem solvers and key players for improvements, as employees or entrepreneurs. Indicators of success are the number of papers published and PhDs produced, as well as the number of innovations created and their value.

We can easily determine that JVTC's results in terms of the number of papers published and PhDs produced are excellent. Moreover, we can pinpoint examples of highly valued innovations stemming from knowledge created and PhDs fostered at JVTC. Nevertheless, concerning innovations, we want to become as systematic and value-driven in that area as we are concerning new knowledge and PhDs. Consequently, we have now developed a strategy of innovation for JVTC and I am both honoured and inspired to be a member of the JVTC team, participating in their efforts to provide excellent research and make the strategy of innovation operational and successful.

I would like to express my sincere thanks to the researchers, members, partners and management of the Center for their engagement and accountability, and for the smart and creative solutions produced for complex railway problems. I would also like to thank the members of the JVTC Board for their enthusiasm, support and guidance during the year.



Rune Lindberg
Luleå Railway Research Center,

February 20, 2013

Photo: Per Nilsson

Director´s Report

During the past few years we have taken the initiative to align our research activities to address the current and the long-term future issues of the railway sector, and have oriented our strategic focus to develop tools and technologies for reliable and robust transport systems. Moreover, we are committed to the development of approaches for energy conservation and sustainability through good maintenance in the railway sector. When I say good maintenance, I mean maintenance activities and action plans that balance the business goals with the needs of present-day society and future generations. Our operations are aligned to facilitate innovations using knowledge generated through our academic and research activities.

Our efforts of the past few years have resulted in establishing us as a leading and attractive partner for EU Framework Programmes. Currently we are involved in eight research projects within the framework of EU FP 7 under different programmes. Last year we also initiated an integration project called ePilot to develop a demonstrator using new and emerging technologies to integrate all the critical operations and decisions to ensure reliable and robust railway systems. We have also signed an MoU with the much discussed Shift-2Rail consortium with a projected budget of more than 800 Million Euros.

I would like to take this opportunity to thank the management of Luleå University, my colleagues at the University, and our supporting partners in industry for the successful results accomplished in the year 2013.

Finally, I would like to thank the members of the Board of JVTC, in particular our Chair, Rune Lindberg, for their guidance and support to the management team throughout the year. I also wish to take this opportunity to thank the members of the management team, for their faith and continuous support throughout the year. It is with great pleasure that I present the Annual Report of Luleå Railway Research Center, covering the activities, results and important events for the year 2013. The Annual Report demonstrates our continued commitment to academic and research excellence leading to useful innovations.

Professor Uday Kumar
Luleå University of Technology
February 21st, 2014

About JVTC
Luleå Railway Research Center

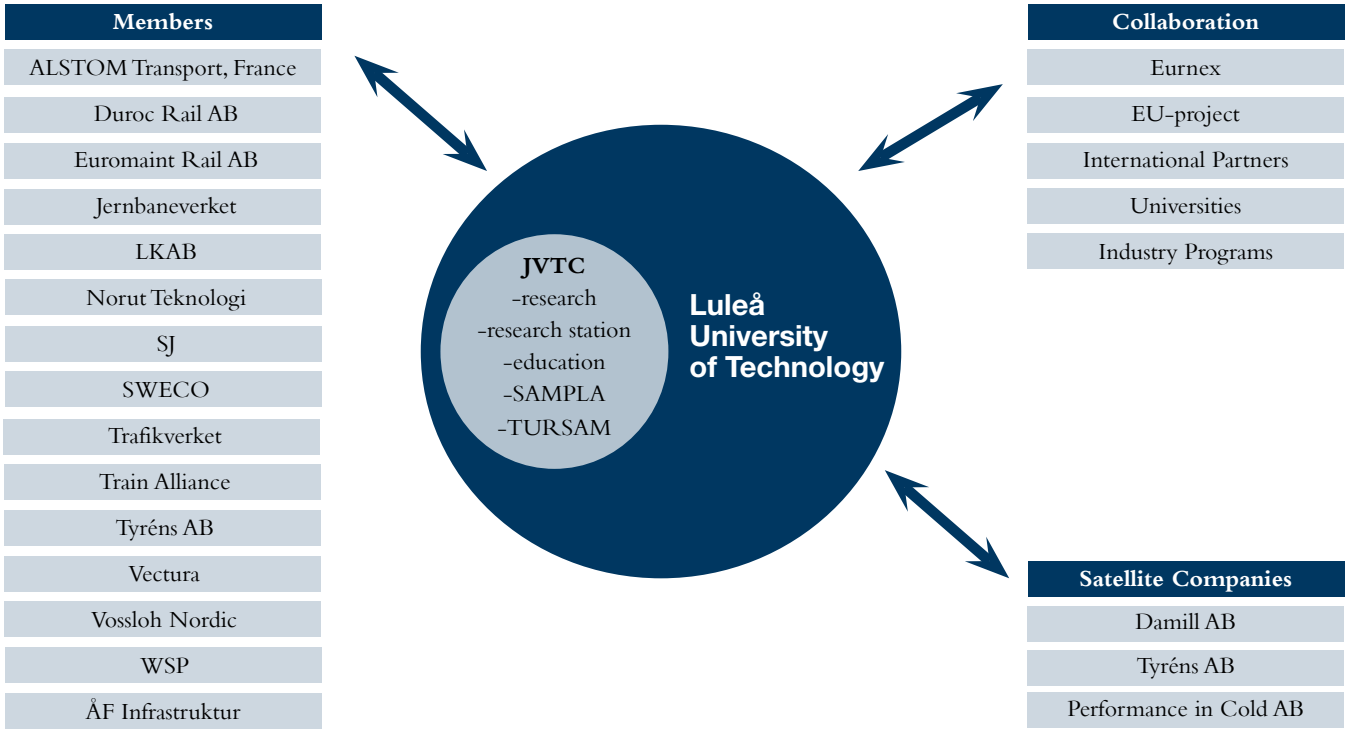
Järnvägstekniskt centrum (JVTC) was established in 1998 and during the last 15 years it has built up a research program adopting a distinctive multidisciplinary approach to meet short term and long term challenges faced by the operation and maintenance engineers of the railway sector.

A key challenge for the modern railway sector is to improve its competitiveness while ensuring a reliable and sustainable mode of transportation for passengers and goods. This essentially necessitates an effective and efficient operation and maintenance of infrastructure and rolling stocks.The strategic focus of JVTC is to develop methods, models, methodologies and technology to make the railway sector computational and a sustainable mode of transportation through industry sponsored Research & Innovation (R&I).

Keeping in mind the fact that operation and maintenance of the railway system is a multi-disciplinary area, the management at JVTC has continuously been working to strengthen its position by networking with researchers with similar interests locally and all over the world. Today, JVTC have collaboration with researchers from Australia, India, France, Norway, UK, Germany etc through various EU sponsored or other applied projects. The main focus of JVTC is to develop new and innovative engineering solutions to enhance the effectiveness and efficiency of the operation and maintenance of railway systems to ensure an economically viable, reliable, punctual safe and sustainable mode of transport system. The R&I activities of JVTC are built around these keywords: Safety, Sustainability, Availability and Capacity.

The center has built up world class competence in the areas of RAMS, maintenance threshold limits and eMaintenance. These three research areas bring strategic focus to some critical research topics which have considerable impact on the performance of railway systems.

About JVTC



JVTC Stakeholders: Members, Collaboration partners, Satellite Companies and Luleå University of Technology.

Organisation

JVTC, is a competence center located at Luleå University of Technology and is organized directly under the president of the University and is managed by the Director under the guidance of the JVTC Steering Board. The main purpose of establishing JVTC as a center of excellence is to co-ordinate all the activities within the university related to satellite members, companies and interested parties. The information exchange between these different stakeholders of JVTC, provide the Swedish railway a system to strive towards a high level of effeciency and effectiveness. JVTC Satellite companies are used when it comes to utilisation of various field tests, laboratory tests, project analysis, product development and acceleration of research processes.

Management

from Luleå University of Technology

- Uday Kumar, Director
- Veronica Jägare, Manager
- Matti Rantatalo, R&I co-ordinator
- Cecilia Glover, Project co-ordinator
- Li Ek, Project controller
- Katarina Grankvist, communicator

Members

A number of Swedish industries and organizations have joined JVTC under different levels of membership. The following companies and organizations were members of JVTC at the close of 2013:

- Luleå University of Technology
- ALSTOM Transport, France
- Duroc Rail AB
- Euromaint Rail AB
- Jernbaneverket
- LKAB
- Norut Teknologi
- SJ
- SWECO
- Trafikverket
- Train Alliance
- Tyréns AB
- Vectura
- Vossloh Nordic Switch Systems
- WSP
- ÅF Infrastruktur

JVTC Steering Board

- Rune Lindberg, Chairman, RAL Innovation
- Alf Helge Lohren, JBV
- Birgitta Olofsson, Tyrens AB
- Christian Eriksson, Trafikverket
- Dan Larsson, Damill AB
- Eskil Sellgren, WSP
- Michael Huy Than, Vectura
- Milan Veljkovic, Luleå University of Technology
- Roland Larsson, Luleå University of Technology
- Susanne Rymell, SJ
- Thomas Nordmark, LKAB
- Björn Lundvall, Vossloh Nordic Switch system (Adjunct)
- Björn Svanberg, SWECO (Adjunct)
- Anders Ekberg, CTH (Adjunct)
- Sebastian Stichel, KTH (Adjunct)
- Thomas Aro, Duroc Rail AB (Adjunct)

Satellite Companies

- Damill AB
- Tyréns AB
- Performance in Cold AB

Strategic R&I Program

The strategic focus of the railway research and innovation programs is to develop new tools, methods and models that will facilitate innovative solutions to railway problems related to the railway system.

The strategic focus of the research programs is to ensure increased availability, capacity, safety and sustainability of the railway network and rolling stocks by effective operation and maintenance. Considerable research is being undertaken to study the track maintenance and renewal issues with focus on grinding, lubrication, maintenance strategies and track degradation. JVTC has also initiated a Human Factors research program in order to gain knowledge of human factors related issues & challenges in the Railway Maintenance.

Areas included in the JVTC R&I Programs are as follows in the figure below.

JVTC Engineering and Management Programs for increased capacity, availability, safety and sustainability on railway.

Dependability	Information logistics	Wear and Failure reduction	Maintenance management and Human Factors
■ RAMS	■ eMaintenance solutions	■ Condition monitoring	■ Human, Technology and Organization (HTO)
■ LCC	■ Database integration	■ Wear and friction control	■ Human Factors /Ergonomics
■ Risk analysis	■ Visualisation	■ Threshold limits	■ Maintenance organization
■ Data mining	■ Content management	■ Modeling of track geometry	■ Maintenance contracts
■ Maintenance optimization and modeling	■ Information flow	■ Component improvements	■ Performance Measurements
■ Design for reliability and design for maintainability	■ Demonstrator	■ Grinding optimization	■ Models for implementing new knowledge
	■ Data mining	■ Demonstrator for testing on rail	■ Maintenance workflow optimization
			■ Maintenance process and procedure analysis

Research Programs

Dependability Program

RAMS (Reliability, Availability, Maintainability and Safety) characteristics for a railway system can be described as the confidence with which it can guarantee the achievement of an agreed volume of traffic with defined quality in a given period. With increase in performance demands from governments, infrastructure managers and train operators are under pressure, to enhance the RAMS characteristics of their operating systems. As a result, during the last 5-7 years, RAMS issues have become critical for competitiveness and economic viability of the railway systems all over the world. Currently, JVTC is engaged in projects which have direct or indirect focus on RAMS analysis. Two of these projects are within the framework of EU FP 7 Program and JVTC is one of the key players for the analysis of RAMS of railway systems.

Wear & Failure Reduction Program

The concept of "maintenance limit" is a new and innovative way to look at the operation and maintenance of railway system as a single entity to ensure high level of transport system reliability. The concept is based and analogous to safety limit used since many decades. The term maintenance limits is used to show that the maintenance decision should be based on knowledge about degradation rates and taken in such a good time that corrective maintenance can be avoided. Maintenance limits also implicates that the total cost for maintaining rail and wheel sets combined, should be used as a parameter for maintenance decisions. Currently, JVTC is running projects within the framework of maintenance threshold.

Maintenance Management & Human Factors Program

Increasing awareness of people regarding environment, focus on sustainable life style and similar other factors, there is pressure to increase the capacity of the existing network so that number of goods and freights trains can be increased on the existing network.

The increase in volume of rail traffic often leads to reduction of maintenance time window of rail track and other infrastructure, which gradually affects the reliability and availability which eventually leads to reduction in track capacity. The aims of these projects are to increase the capacity of the existing railway infrastructure through an effective and efficient maintenance process.

The overall purpose of this part of the program is to help the Swedish railway sector to increase their competitiveness by improving maintenance work processes, safety and the reduction of human error/or failure during maintenance activities through the implementation of human factors principles. The fundamental goal of the human factor is that all man-made tools, devices, equipment, machines, and environments should advance, directly or indirectly, the safety, well-being, and performance of humans.

eMaintenance
Information Logistics Program

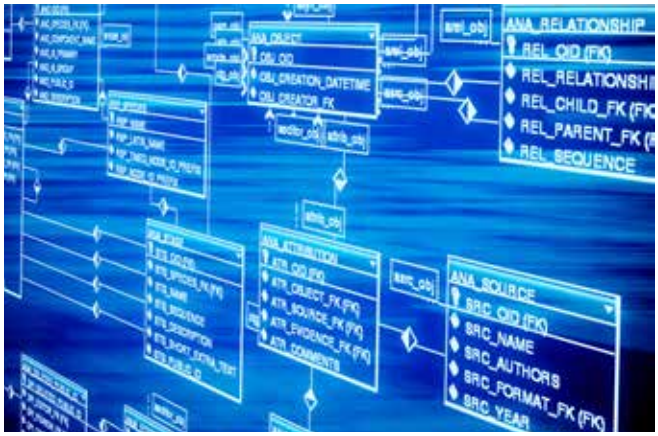
The goal of the Information Logistics Research Program is to overcome shortcomings in the operation and maintenance system by looking at how to offer operatiors, maintenance staff, infrastructur managers and system integrators to access a real time computerized system from data to decision. The concept behind the research program is to facilitate research, results and education in operations and maintenance by providing tools for advanced data mining and data analysis. We aim to assist the industry so they could easily implement this architecture and utilize our expertise for their maintenance, research and testing program. eMaintenance LAB has locations at the university in Luleå and a facility developed for LKAB in Kiruna, Sweden.

These labs are developed for online cloud application to feed data collected from industry from any outlaying location to the laboratories. Among the studies at the laboratory is a project to measure the impact of varying loads on track infrastructure and the performance and condition of wheels. This is to estimate their remaining service life and to predict when replacements are required. The results of this analysis are delivered to the client in a variety of ways – direct to handheld devices used by maintenance staff, a pure HTML web-based interface, or an email. What we are trying to do is to build cooperation between industry, academia and research. eMaintenance conferences, in cooperation with the lab and industry partners and projects, are used to assist in developing capabilities and experiences which will facilitate our further growth.

Our strategy is to provide artefacts (e.g. frameworks, tools, methodologies, and technologies) that address the industrial priorities expressed through 'Data Fusion', 'Information Sharing', 'Seamless Connectivity', and 'Distributed Real-time Data Processing'. These artefacts will deal with challenges such as cross domain connectivity, communication capability, interoperability between ambient and distributed environments, data fusion, maintenance content management, data quality, information visualization, and real time distributed data analysis capability.

Research PROJECTS 2013

There are about 25 R&I projects in progress within the center related to maintenance and the railway system



Maintenance Decision Support Models for Railway Infrastructure using RAMS

Sponsor: Swedish Transport Administration

Researcher: Uday Kumar

Objective: Illustrate and demonstrate the applicability of RAMS and LCC analysis in the decision making process governing the cost effective maintenance of the railway infrastructure, taking the associated risks and uncertainties into consideration. In this project, models are developed to estimate RAMS targets based on punctuality, capacity and safety requirements.

Duration: 2012 - 2015

Intelligent Fault Detection on Railway Power Supply System

Sponsor: Swedish Transport Administration

Researcher: Yuan Fuqing

Objective: Use signal processing technique to extract the salient features which characterize system from time and frequency domain.
The power supply system is crucial to the operation of electrified railway line. This research aims to detect the undergoing defect before serious failure occurs. Machine learning algorithm such as Support Vector Machine (SVM) is used to model the interaction between some sub-systems such as overhead contact line and pantograph in the power supply system. Efficient signal processing technique is used to extract the salient features which characterize system from time and frequency domain. The results of the research will be further used to optimize the maintenance policy, and therefore can reduce cost and improve the railway availability.

Duration: 2012 - 2013

eMaintenance solutions for effective decision-making in maintenance

Sponsors: Swedish Transport Administration, Vattenfall Vattenkraft, Vattenfall Services & Saab Support Service

Researchers: Mustafa Aljumaili, Yasser Ahmed Mahmood, Olov Candell & Ramin Karim

Objective: This project aims to explore and describe how the appropriate information logistics as support to the maintenance process can be established.

Duration: 2009 - 2013

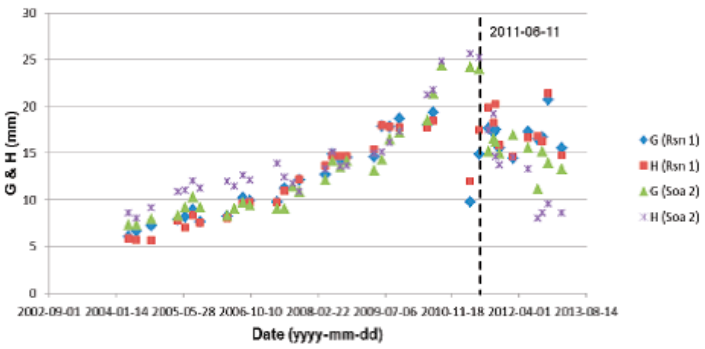
Maintenance Thresholds

Sponsor: Swedish Transport Administration

Researchers: Iman Arasteh Khouy & Per-Olof Larsson-Kråik

Objective: The outcome of this research is maintenance decision support model to specify cost-effective maintenance thresholds for railway track and wheels.
In the past, railway maintenance procedures were usually planned based on the knowledge and experience of the company involved. The main goal was to provide a high level of safety, and there was little concern for economic issues. Today, however, the competitive environment and budget limitations are forcing railway infrastructures to move from safety limits to maintenance limits in order to optimize operation and maintenance procedures. By discussing maintenance limits instead of safety limits, one widens the focus to comprise both operational safety and cost-effectiveness for the whole railway transport system. Using maintenance limits means balancing maintenance performance measures against economics with a view of achieving the estimated service life and delivering the function required at the right price. A methodology to optimize track geometry maintenance by using historical geometry data has been developed. The methodology is based on reliability and cost analysis and facilitates maintenance decision-making process to identify cost-effective maintenance thresholds.

Duration: 2009 - 2013



Condition based maintenance for Vehicles

Sponsor: HLRC
Researchers: Mikael Palo & Per-Olof Larsson-Kråik
Objective: The wear at the wheel/rail interface is an important problem in the railway field. The evolution of the profile shape due to wear has a deep effect on the vehicle dynamics and on its running stability, leading to performance variations both in negotiating curves and in straight track.
Wheel condition has historically been managed by identifying and removing wheels from service when they exceed a vertical impact load threshold. These thresholds are typically based on when a wheel/rail impact is presumed to cause sufficient stresses to the track structure.
The aim of the project is to use both wheel/rail forces and wheel profiles data when doing condition monitoring. This would give a much more reliable result than using the vertical impact load threshold.
Duration: 2009 - 2014

Link and effect model of maintenance investment for infrastructure effectiveness improvement

Sponsor: Swedish Transport Administration
Researchers: Christer Stenström, Aditya Parida & Uday Kumar
Objective: The aim of the project is to develop a "link and effect" model to improve the total effectiveness of the maintenance system for the railway infrastructure.
To manage the railway infrastructure assets effectively against agreed and set objectives, the effect of maintenance works must be measured and monitored. Different systems are used for collecting and storing data of traffic, failures, inspections and track quality data, etc., for analysis and exchange of performance indicators (PIs) for RAMS, capacity, punctuality etc, to identify performance killers and in making more efficient and effective decisions. A link and effect model can provide information regarding performance killers and cost drivers, it increases the knowledge of how railway systems and components are interlinked, facilitating accurate decision making, for efficient and effective railway infrastructure operation. The objective is to develop a link and effect model to improve the total effectiveness of the maintenance system for the railway infrastructure.
Duration: 2010 – 2014

Integrated Reliability Analysis for Maintenance Strategies Optimization

Sponsor: LKAB
Researcher: Janet (Jing) Lin
Objective: This study aims to develop new models for integrated reliability analysis, by which to support decision making on maintenance strategies optimization.
Duration: 2012- 2014

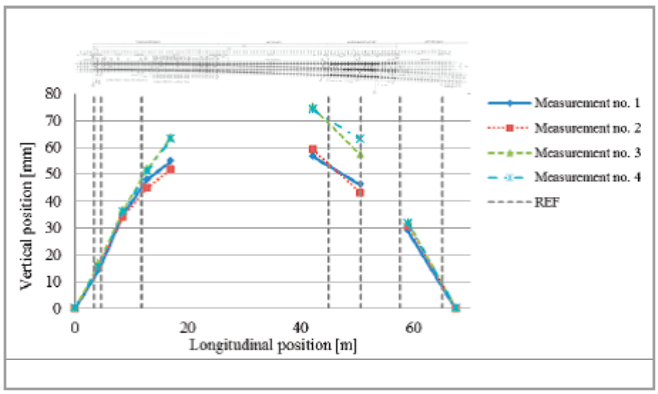
Optimal methods for innovative product development and decision support (OptiKrea)

Sponsors: Vossloh Nordic Switch Systems, Swedish Transport Administration & Infranord
Researchers: Anna Malou Petersson, Matti Rantatalo, Jan Lundberg
Objective: To generate a collaboration between managers, suppliers and maintenance contractors so that it drives the technical development of railway products, and especially turnouts, forward to achieve lower maintenance and life cycle costs as well as increased punctuality. The goal is to develop working methods facilitating innovation that are tailor-made for the railway sector.
Duration: 2012-2016

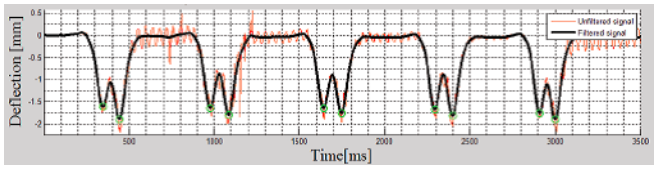
Improve availability and reduced life cycle cost of track switches

Sponsor: Swedish Transport Administration
Researchers: Jens Jönsson, Matti Rantatalo & Jan Lundberg
Objective: Develop a LCC model taking into account diagnostics data from track recording cars (used in Sweden) and develop a prognostics tool for more efficient maintenance strategies of track switches.
Track switches are critical units in railway systems, as they perform the switching procedure that guides trains along different routes. To maintain their functional requirements there is a need to predict the track geometry change affected by different operating and ambient conditions. This project contain several case studies where measurements has been performed on the Swedish infrastructure, to determine long term track geometry changes and the effect of different load conditions related to the vertical deflection of the track seen in the figures below. The knowledge gained in the project will be used to develop a LCC model and a prognostics tool for more efficient maintenance strategies of track switches. The effects obtained from the project include:
- Evaluation and development of measurement methods for measurement of track geometry changes over time and measurements of dynamic displacement on rail
- Development of a LCC model for predicting effective maintenance of switches

Duration: 2012-2016



Vertical displacement measurement of switch.



Laser measurements of the vertical rail displacement

RAMS analysis of railway signaling systems

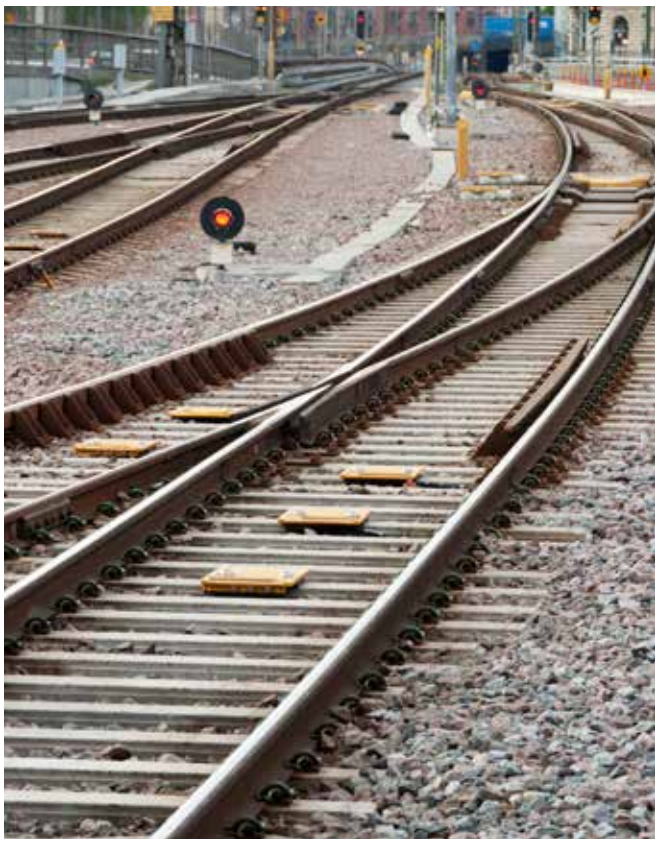
Sponsors: JVTC & Swedish Transport Administration
Researchers: Amparo Morant & Per-Olof Larsson-Kråik
Objective: This research analyses the dependability and maintenance of railway signaling systems and proposes various approaches to improve maintenance performance.
The purpose of this research project is to explore the areas that could improve the performance of railway signaling systems during the operation life cycle phase, by enhancing their dependability. A data driven model for maintenance decision support is proposed, based on corrective maintenance work orders. With this model, existing maintenance policies could be reviewed and improved upon. The results show that different factors affect greatly the performance of signaling systems (e.g. the complexity of the system, accessibility and others related to the location). Measuring how much those factors affect signaling systems would allow better estimations of RAMS during operation. 70% of the total failures related of signaling system are recorded as no fault found, not defined or non-operative. Improving the maintainability and the maintenance supportability of the systems can reduce the time needed to identify the required corrective maintenance action and reducing the NFF WOs. This project proposes some improvements for enhancing the dependability of railway signaling systems, such as a model for configuration management and a framework for improving inter-organisational knowledge management between stakeholders.
Duration: 2012 - 2013

Top of Rail lubrication

Sponsors: Swedish Transport Administration & JVTC
Researchers: Matti Rantatalo, Jan Lundberg, Johan Casselgren & Yonas Lemma
Objective: To examine if the top-of-rail lubrication will reduce the wheel/rail forces and if the lubrications can be used in cold climates.
Swedish Transport Administration and LKAB have installed a Top of Rail (ToR) Lubrication equipment for investigate the performance of the system in cold climates. This was done 2013 at two different locations along the Iron Ore line, one in the northern part of the line and one in the southern part. Figure 1 shows one of equipment at the northern part of the line.
Duration: 2013-2015

Effective Maintenance Execution with Human Factor Interventions

Sponsors: Swedish Transport Administration /JVTC & Euromaint
Researcher: Sarbjeet Singh
Objective: Develop easy to implement guidelines for good maintenance practices through human factor interventions.
This project focuses on human factor interventions for effective maintenance execution and to improve the performance of railway maintenance system. The sub goal of this project are (i) identification of factors influencing human errors, (ii) improvement of performance shaping factors in the context of railway maintenance (iii) Evaluation of Human Error Probability in Railway Maintenance tasks.
Duration: 2012 - 2015



Developing a method for the specification and selection criteria for technical systems and equipment

Sponsor: Swedish Transport Administration
Researcher: Jan Lundberg
Objective: The aim of the project was to develop methods to find optimal technical specifications and optimal selection of the products.
Duration: 2010 - 2013

Maintenance Improvement: an opportunity for Railway Infrastructure Capacity Enhancement

Sponsor: Swedish Transport Administration
Researchers: Stephen M. Famurewa, Matthias Asplund, Matti Rantatalo & Uday Kumar
Objective: The objectives of this project are to develop maintenance decision support models and deploy effective condition monitoring systems for critical items to reduce maintenance possession time.
The management of outages or track possession time for maintenance is an aspect of railway infrastructure management with promising potential. The allocation and utilization of possession time for maintenance requires improvement if the track design capacity and reliable service is to be achieved. The required improvement is not only limited to preventive maintenance but also extends to the strategy of handling unexpected interruptions. A typical improvement framework designed for the enhancement of capacity and quality of service on existing infrastructure is shown in the left hand Figure. The project involves identification of processes, activities or even subsystems that restrain the flow of traffic, limiting the capacity or cause delay on a line or network. A case study to identify critical higher level systems (traffic areas represented with numerical code) on a selected track section is presented in the right hand figure. Other key issue addressed in the project is the analysis of intervention measures using relevant optimization techniques. The outcome of this will be reduction in track outages due to planned or unplanned maintenance activities and thereby improving the capacity situation of railway network.
Duration: 2010 - 2015

Innovation project

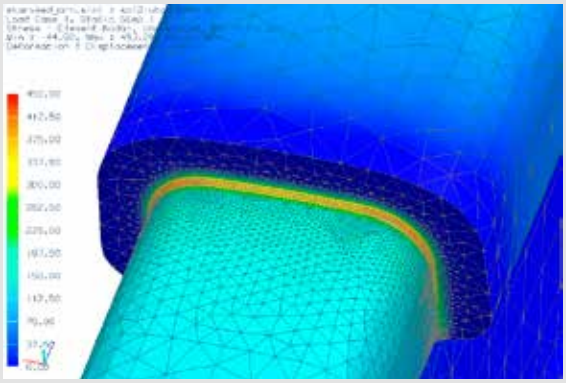
ReRail Innovation

Sponsor: Vinnova

Researcher: Anders Sundgren

Objective: The project ReRail is sponsored by VINNOVA and engaged in developing a new innovative concept to prolong the life of the existing worn out rail. The outcome from the project will help Transport Companies to meet CO2 emission target. The project is led by Prof. Uday Kumar and the principal investigator is Anders Sundgren owner of Rerail AB. It consists of a rolling format, modern hardened steel, which forms a wear surface. The hardened steel in ReRail is nearly twice as hard as normal rail steel. ReRail tread is about 10 mm thick and is mounted around the head of the original rail which is milled down when it is worn out and adapted to the tread of the internal form. The advantage of a two-track rail is that it can be renovated into place, then only the surface needs to be replaced. The production of 10 000 meter rail produces around 24 000 tonnes of carbon dioxide. With ReRail the emissions is reduced to about 5000 tons.

Duration: 2010 - 2013



Implementation project

ePilot 119

Sponsor: Swedish Transport Administration

Researcher: Ramin Karim

Objective: Increase cooperation and the sharing of data among railway partners by using eMaintence,

In an industry collaboration between JVTC, the Swedish Transport Administration, railway companies, maintenance contractors for vehicles and infrastructure, and consultants is an implementation project called ePilot119 on the iron ore line initiated.

Since 2005, work has been conducted within the Luleå Railway Research Center (JVTC) with the aim of using different types of condition based data to develop a decision support. This is so that preventive measures can be taken in the railway system before errors and disturbances. Working with prevention rather than corrective action is a more cost effective way to conduct maintenance activities.

It is a cross-organizational area based on information logistics to ensure that maintenance is carried out in line with both the customer and the supplier's business objectives to take care of inherent elements in all parts of a system's life cycle. There is a strong link between the infrastructure and the vehicles that use it. By using condition based data from across the railway sector and its stakeholders a good basis is established to take the right decision at the right time.

The approach is based on enhanced collaboration methodology with a framework project and a central project team that is cohesive for smaller sub-projects within the framework project. For projects and process management JVTC is using its satellite companies. The purpose of the pilot project is to implement an eMaintenance demonstration that leads to a higher avalibility, enhanced capacity and a more cost efficient railway operation. This can be achieved when the rail system's stakeholders, builds a shared platform (initially eMaintenanceLab) for information sharing of decision data for high quality and cost effective maintenance.

The pilot project includes track 119 between Boden and Luleå and is supposed to last for three years and then rolled out to other parts of the railway industry.

Duration: 2013-2016

EU Research PROJECTS 2013

At present, under the JVTC platform, seven EU projects are being executed such as; Automain, SustRail, TREND, BGLC, Mainline, SAFT Inspect and Optirail. The descriptions of stated EU projects are given below.

AUTOMAIN

An EU project for Augmented Usage of Track by Optimisation of Maintenance, Allocation and Inspection of railway Networks

Sponsors: EU, FP7 (Seventh Framework Programme) & The Swedish Transport Administration

Researchers: Ulla Juntti, Uday Kumar, Aditya Parida, Christer Stenström, Stephen Famurewa Mayrowa, Matthias Asplund, Matti Rantatalo & Iman Arasteh Khouy

Objective: The aim of the project is to make the movement of freight by rail more dependable (reliable, available, maintainable and safe) in order to generate additional capacity on the existing network.

The high level aim of the project is to make the movement of freight by rail more dependable, i.e. reliable, available, maintainable and safe through the generation of additional capacity on the existing network. Through the widespread introduction of automation that is designed to improve the Reliability, Availability, Maintainability and Safety (RAMS) of railway infrastructure equipment and systems, it is anticipated that required possession time (downtime) of the railway could be reduced by as much as 40%. The project is on-going and will deliver five key innovations in the area of railway infrastructure maintenance improvement. Each of the innovations will individually either speed-up and/or help optimise existing maintenance processes, which will in turn reduce the possession time required and create capacity for freight. (For project overview, see: http://www.automain.eu/). LTU/JVTC provides knowledge, experience and expertise in WPs 1, 2 and 3 and is the work package leader for WP4 for "High performance maintenance". WP4 will provide more capacity for freight trains by strengthened and increased efficiency of high performance maintenance by speeding up large scale maintenance and develop a modular approach for maintenance of switches and crossings. This will be achieved by elimination/isolation of performance killers, cost and risk drives through a link and effect model and capacity optimization.

Duration: 2011 - 2014

SustRail

Sponsors: EU, FP7 & The Swedish Transport Administration

Researchers: Matti Rantatalo, Stephen Famurewa, Ulla Juntti & Lennart Elfgren

Objective: The Sustrail objective is to contribute to the rail freight system to allow it to regain position and market, accounting for the increase of the demand of the total freight transport volumes: 40% (in tonne-kilometres) by 2030 and 80% by 2050; The shift of 30% of road freight over 300km to other modes.

SUSTRAIL aims to contribute to the rail freight system to allow it to regain position and market and the proposed solution is based on a combined improvement in both freight vehicle and track components in a holistic approach aimed at achieving a higher reliability and increased performance of the rail freight system as a whole and profitability for all the stakeholders. The SUSTRAIL integrated approach is based on innovations in rolling stock and freight vehicles (with a targeted increased in speed and axle-load) combined with innovations in the track components (for higher reliability and reduced maintenance), whose benefits to freight and passenger users (since mixed routes are considered) are quantified through the development of an appropriate business case with estimation of cost savings on a life cycle basis.

JVTC/Division of Operation and Maintenance is involved in two work packages in the European 7:th framework research project Sustrail. WP4: Sustainable track and WP5: Business case.

WP4: Sustainable track

This work package will facilitate the need for the railway infrastructure to accommodate more traffic whilst at the same time reducing deterioration of track and wheels through increasing the resistance of the track to the loads imposed on it by vehicles. This will assist in sustainable achievement of increased speed and capacity for freight traffic, thus contributing towards making rail freight more competitive. There is a very strong coupling to WP3 since it is essential to undertake a systems approach to analyse the combined track and vehicle loads and deterioration. The outputs from the WP will also inform the decision making for WP5 that will select the most promising infrastructure technologies for testing and demonstration.

WP5: Business Case

This work package considers the business case and implementation issues associated with the vehicle and track options developed in WP3 and WP4 respectively. The work package will act as both an iterative filter for the options developed in WP3 and WP4 in order to help focus the engineering development to those options which are likely to have greatest overall net benefits, as well as providing a final business case appraisal for the preferred option. The assessment will include quantifying the Life Cycle Cost (LCC) of each option and a Reliability, Availability, Maintenance and Safety (RAMS) analysis.

Duration: 2011 – 2014

TREND

Sponsors: EU, FP7 & JVTC
Researchers: Diego Galar, Uday Kumar & Emilio Rodríguez
Objective: The main objective of the project is to the design of a test setup that enables the harmonization of freight and passengers rolling stock approval tests for electromagnetic compatibility (EMC) focusing not only on interferences with broadcasting services but also on railway signalling systems.

TREND (Test of Rolling Stock Electromagnetic Compatibility for cross-Domain Interoperability) project has the objective of addressing this situation by means of the design of a test setup that enables the harmonization of freight and passengers rolling stock approval tests for electromagnetic compatibility (EMC) focusing not only on interferences with broadcasting services but also on railway signalling systems. TREND will also identify and design the test sites and cross-acceptance test lines on electrified and non-electrified lines that reproduce representative worst case conditions.

The nuance introduced by the word "representative" is key to focus on the harmonization of the resulting tests and the contribution of the TREND project to unified and ultimate EMC approval tests. The five specific objectives of the TREND project are detailed in the following list:

1. Modelization of the railway system and the electromagnetic interferences affecting the communication systems in a complete railway environment to obtain the representative worst case conditions for EMC approval tests Identification and design of test sites for electrified lines and non-electrified lines that reproduces representative

2. Worst case conditions
Design of a test setup and test site that enables the harmonization of freight and passengers rolling stock

3. Approval tests for electromagnetic compatibility focusing not only in interferences with broadcasting services but also in railway signalling systems so cross-domain compatibility is achieved.
Design of a test procedure that recreates representative worst case conditions for the rolling stock
4 electromagnetic emissions that could affect interoperability including transient phenomena, and processes captured data so electromagnetic compatibility can be demonstrated and safety and availability can be assessed.

Dissemination of the results to the main stakeholders in the European railway industry acting on 6 fields,
5 putting special emphasis on the proposition for the standardization organizations which will have a strong and direct impact on the safety of the railway users

Duration: 2011- 2014

BGLC – Bothnian Green Logistic Corridor

Sponsor: Baltic Sea Region, The Bothanian Corridor

Researchers: Ulla Juntti, Aditya Parida, Christer Stenström & Stephen Famurewa

Objective: The overall objective of BGLC is to increase the integration between the northern Scandinavia and Barents, with its vast natural resources and increasing industrial production, with the industrial chain and end markets in the Baltic Sea Region and central Europe.

The aim of the project is to present quantifiable, green, resource-efficient and reliable transport solutions that meet the needs of the future.

To apply the Green Corridor concepts in multi-modal logistic chains by improvements in freight hubs and terminals including dry ports, along the Bothnian Corridor and its extension in north-south and east-west directions (WP3).

To highlight solutions to cross border obstacles in the Bothnian Corridor transport system. (WP3)

To pilot greening of transports and improved transport business development for selected types of cargo along the Bothnian Corridor and its extensions. (WP4)

To study the impact of the Bothnian Corridor infrastructure on industry and regional economic growth. (WP5)

To establish a network for logistics stakeholders collaboration for further improvement and optimized use of the Bothnian Corridor transport system and develop a Bothnian Green Transport Strategy. (WP6)

Duration: 2011 - 2014

MAINLINE

Sponsor: EU FP7

Researcher: Lennart Elfgren

Objective: The main obectives of the MAINLINE are to develop new technologies to extend the life of elderly railway infrastructure across Europe, improve degradation & structural models to develope more realistic life cycle cost & safety models and to investigate monitoring techniques to complement or replace existing examination methods.

Growth in demand for rail transportation across Europe is predicted to continue. Much of this growth will have to be accommodated on existing lines that contain old infrastructure. This demand will increase both the rate of deterioration of these elderly assets and the need for shorter line closures for maintenance or renewal interventions. However, interventions on elderly infrastructure will also need to take account of the need for lower economic and environmental impacts. This means that new interventions will need to be developed. In addition tools will need to be developed to inform decision makers about the economic and environmental consequences of different intervention options being considered. MAINLINE proposes to address all these issues through a series of linked work packages that will target at least 300m per year savings across Europe with a reduced environmental footprint in terms of embodied carbon and other environmental benefits.

The main objectives of the MAINLINE are to develop new technologies to extend the life of elderly railway infrastructure across Europe, improve degradation & structural models to develop more realistic life cycle cost & safety models and to investigate monitoring techniques to complement or replace existing examination methods.

The project will:

- Apply new technologies to extend the life of elderly infrastructure
- Improve degradation and structural models to develop more realistic life cycle cost and safety models
- Investigate new construction methods for the replacement of obsolete infrastructure
- Investigate monitoring techniques to complement or replace existing examination techniques
- Develop management tools to assess whole life environmental and economic impact.

The consortium includes leading railways, contractors, consultants and researchers from across Europe, including from both Eastern Europe and the emerging economies. Partners also bring experience on approaches used in other industry sectors which have relevance to the rail sector.

Duration: 2011 - 2014

SAFT Inspect: Ultrasonic synthetic Aperture Focusing Technique for Inspection of Railways Crossings (Frogs)

Sponsor: EU, FP7

Researchers: Matti Rantatalo, Jan Lundberg & Johan Carlsson

Objective: Increase industrial confidence in NDT by achieving better quality levels in the identification, classification and sizing of defects compared to existing techniques.

SAFTInspect aims to develop an affordable and reliable ultrasonic inspection solution for sections of high manganese steel rail crossing points, which are used in the European railways. A non-destructive testing (NDT) inspection solution will be developed in the project to facilitate early defect detection of crack defects at safety critical locations. The project results will increase industrial confidence in NDT by achieving better quality levels in the identification, classification and sizing of defects compared to existing techniques. The automated output will increase efficiency and reduce scanning mistakes associated with manual methods. The rapid, automated solution will reduce time required for personnel to be located in potentially hazardous environments. This will provide NDT workers with safer, healthier and better working conditions in European industry related inspection and maintenance activities. The proposed project will focus on the rail transport industry within the EU. However techniques developed by the project would not be specific to high manganese steel rail track, but applicable to many other coarse grained, anisotropic or non-homogeneous materials.

Duration: 2012 - 2014

Optirail

Sponsors: EU, FP7 & JVTC

Researcher: Diego Galar

Objective: Railway services are characterized by a high degree of reliability and safety. The increasing use of railway also increases the need for maintenance, not only because of a higher degradation of the system, but also because the availability of the track for maintenance decreases. A major constraint when organizing maintenance tasks is to avoid disruption of service.

The OPTIRAIL project will develop a comprehensive tool, based on Fuzzy and Computational Intelligent techniques, to manage all the elements that are relevant for track maintenance, predicting future conservations needs with optimal allocations of resources. To allow better understanding of complex infrastructure behavior, extending as a consequence, the lifecycle and durability of networks and reduce the environmental impact.

OPTIRAIL will contribute to obtain higher levels of safety and service in railway infrastructures, “optimal” life cycle for the management of railway infrastructure maintenance, better quality of service and, therefore, higher level of client satisfaction, improved level of availability of the railway infrastructure. OPTIRAIL will also ensure a more effective planning of the management and activities of infrastructure maintenance based on expert knowledge accumulated over years of experience and to the information stored in the monitoring and maintenance management systems.

Duration: 2012 - 2015

Maintenance Research Laboratries & JVTC Research Station

JVTC Research Station

To stream line data collection to meet research requirement, JVTC has established a measurement station in Sävast between Luleå and Boden, to measure forces exerted by vehicles on the track. The mounting pattern of sensors at measurement point separates the vertical and lateral forces. The measured data are automatically transferred to our eMaintenance LAB using internet for processing it into useful information and knowledge that can be used by train operators and infrastructure managers. Some of the high lights of this measurement station are: delivers real time data 24 hours a day, identifies trains and wagons, a top 10 list of poorly performing axels and internet access to real time data. The real time data after processing is displayed in real time in a user friendly manner.

Wheel Profile Measurement Station

Trafikverket and LKAB have installed the first high speed wheel profile measurement system for railway vehicle in service in October 2011. This system is installed an Iron ore line at the northern part of Sweden. This is a project to improve the maintenance of rolling stock and infrastructure. The information from this system goes to eMaintenance LAB at Luleå Research Centre (JVTC) for processing and for research. The iron ore transport operator uses the wheel profile measurement system to detect wheels which fall outside the safety and maintenance limits. The wheel profile measurement system consists of four units with lasers and highspeed cameras. The WPMS extracts the parameters as flange height, flange width, flange slope and tread hollowing. After two years operation the systems shows good measurements accuracy and reliability.

Measuring device at JVTC Research station

Wheel profile measurement system installed in the southern part of the Iron Ore Line

Condition Based Maintenance Lab (CBM LAB)

eMaintenance LAB

The eMaintenance Lab was developed as a platform for developing solutions aimed for maintenance decision making. The Lab. facilitates research and education in maintenance. eMaintenance Lab, is the world's first international eMaintenance laboratory, and is now providing various services to the logistics and maintenance divisions to both national and international research groups. This includes industry and research partners from Slovenien, Spain, Italy, Germany, Norway, Finland, and USA. In the laboratory, the researchers get access to tools that support them in building artefacts such as models, approaches, frameworks, methodologies, technologies, and tools for maintenance decision making. These artefacts use resources in the results for the research activities subsequently improve the lab resources. This creates a process of continuous improvement for the eMaintenance LAB.

Condition Based Maintenance Lab (CBM LAB)

The CBM Lab was established 2013 and is performing experimental research in condition based maintenance. The CBM Lab will constantly increase in activities and experimental equipment to support the research and research education. Examples of equipment are 1:32 scale railway with ballast, locomotives, wagons, turnouts, transition zones, signals, electric contact wire power system, etc. Wireless accelerometers, UL and Syntetic Aperture Focus (SAFT) apparatus and probes, test bench for crack monitoring of gears, optical leveling instrument for railway measurements, video cameras and laser for turnout measurements, micro components for demonstrator design/testing. Ongoing experimental studies are scale experiments of settlements in turnouts, scale experiments of dynamic behavior in railway transition zones, condition monitoring of cracks in gears, new mechanical solutions for tamping of turnouts and SAFT measurements on railway turnout manganese crossings.

Research

Project	Project members	Sponsor	Status
Department of Civil, Environmental and Natural resources engineering/ Division of Operation and Maintenance			
Increased railway infrastructure capacity through improved maintenance practices	Prof Uday Kumar, +46 920-491826 Dr Matti Rantatalo +46 920-492124 PhD candidates: Stephen Famurewa +46 920-492375 2013 – Licentiate thesis Matthias Asplund +46 920-491062	Trafikverket/JVTC	Active
Optimization of track geometry inspection interval (Maintenance limits)	Prof Uday Kumar, +46 920-491826 Dr P-O Larsson-Kråik +46 10-231884 PhD candidate: Iman Arastehkhouy +46 920-2071 2011 – Licentiate Thesis 2013 – Doctoral thesis	Trafikverket/JVTC	Active
Condition based maintenance for Vehicles	Prof Uday Kumar, +46 920-491826 Dr P-O Larsson-Kråik +46 10 231884 PhD candidate: Mikael Palo, +46 920-492009 2012 – Licentiate Thesis	Trafikverket/JVTC/HLRC	Active
RAMS in signalling	Dr P-O Larsson-Kråik +46 10 231884 PhD candidate: Amparo Morant +46 920 2518	Trafikverket/JVTC	Active
OptiKrea - Optimala metoder för innovative produktutveckling och beslutsstöd	Prof Jan Lundberg, +46 920-491748 PhD candidate: Anna Malou Peterssen +46 920-491734	Trafikverket/JVTC/ Vossloh/Infranord	Active
Improved availability and decreased life cycle cost for switches	Dr Jan Lundberg, +46 920-491748 PhD candidate: Jens Jönsson +46 020-491438	Trafikverket	Active
Integrated reliability analysis for maintenance optimization	Dr Janet Lin, +46 920-491564	Trafikverket/JVTC/ LKAB	Active
DeCoTrack, Track degradation modelling and analysis related to change in railway traffic	Prof Uday Kumar, +46 920-491826 PhD candidate: Dan Larsson (Damill AB) 2004 - Licentiate Thesis	Trafikverket	Active
Maintenance human factors ergonomics	Dr Sarbjeet Singh, +46 920-492812	Trafikverket/JVTC/Euromaint	Active
Link and effect models in railway maintenance	Dr Aditya Parida, +46 920-491437 PhD candidate: Christer Stenström + 46 920-491476, 2012 - Licentiate Thesis	Trafikverket/JVTC	Active
Investigation of end-user needs for eMaintenance on Railway	Dr Ramin Karim, +46 920-492344	Trafikverket/JVTC	Active
Top of rail (ToR)	Prof Jan Lundberg, +46 920-491748 Dr Matti Rantatalo +46 920-492124 Dr Johan Casselgren +46 920-491409 PhD candidate: Matthias Asplund +46 920-491062	Trafikverket/JVTC	Active
35-40 tons axellast i arktiskt klimat	Prof Jan Lundberg, +46 920-491748	Trafikverket/JVTC/Norut	Active
ePilot119	Dr Ramin Karim, +46 920-492344 Dr Ulla Juntti +46 920-499091 Veronica Jägare, +46 920-491629	Trafikverket/JVTC	Active
NoRRTeC establish a Swedish-Norwegian research platform	Veronica Jägare, +46 920-491629 Dr Matti Rantatalo +46 920-492124	Interreg/Länsstyrelsen	Active
Bothnian Logistics Green Corridor, BGLC	Dr Ulla Juntti +46 920-491991	Trafikverket/JVTC	Active
Automain	Prof Uday Kumar, +46 920-491826 Dr Ulla Juntti +46 920-491991	EU/Trafikverket	Active

Project	Project members	Sponsor	Status
Sustrail	Prof Uday Kumar, +46 920-491826 Dr Matti Rantatalo +46 920-492124	EU/Trafikverket	Active
TREND	Prof Diego Galar +46 920-2437	EU/JVTC	Active
Optirail	Prof Diego Galar +46 920-2437	EU/JVTC	Active
SAFT Inspect	Dr Matti Rantatalo +46 920-492124	EU	Active
ReRail	Anders Sundgren +46 703-076647	Vinnova	Active
From measurement to maintenance decision	Dr Håkan Schunnesson, +46 920-491696 PhD candidates: Mikael Palo, +46 920-492009 Iman Arastehkhouy, +46 920-492071	Luleå University of Technology, LKAB	Completed
Ergonomic Analysis for Railway Vehicle Maintenance and Workshop Facilities	Dr Rupesh Kumar, +46 920-491685	Trafikverket/JVTC/ LKAB/Euromaint	Completed
Dynamic Maintenance Programme	Dr Ramin Karim, +46 920-492344	Trafikverket/JVTC	Completed
Reliability analysis of Switches and Crossings	Dr Behzad Ghodrati, +46 920-491456	ALSTOM / Trafikverket	Completed
Development of a demonstrator for eMaintenance on Railway	Dr Ramin Karim, +46 920-492344	Trafikverket/JVTC	Completed
Developing a method for the specification and selection criteria for technical systems and equipment	Prof Jan Lundberg, +46 920-491748	Trafikverket	Completed
RAMS and LCC in the planning phase	Dr Ulla Juntti +46 920-491991	Trafikverket/JVTC	Completed
Support vector machine (Demonstrator)	Dr Yuan Fuqing +46 920-49 1682	Trafikverket/JVTC	Completed
Detection of internal flaws in railway manganese crossings by using Synthetic Aperture Focus Technology (SAFT)	Dr Jan Lundberg, +46 920-491748	Trafikverket	Completed
LCC and RAMS for Railway Vehicles	Prof Uday Kumar, +46 920-491826 PhD candidate: Ambika Patra 2007 - Licentiate Thesis	Trafikverket/JVTC	Completed
Maintenance Decision Support Models for Railway Infrastructure using RAMS &LCC Analyses	Prof Uday Kumar, +46 920-491826 PhD candidate: Ambika Patra 2009 - Doctoral Thesis	Trafikverket/ ALSTOM Transport	Completed
Risk based inspection intervals	Prof Uday Kumar, +46 920-491826 Dr Alireza Ahmadi, +46 920-493047	Trafikverket/ Luleå University of Technology	Completed
Support Vector Machine (Data Mining) and demonstrator	Prof Uday Kumar, +46 920-491826 PhD candidate: Yuan Fuqing +46 920-49 1682 2011 - Doctoral Thesis	Trafikverket/JVTC	Completed
Wear in crossings	Prof Jan Lundberg, +46 920-491748	Trafikverket	Completed
Technical specifications for crossings	Prof Jan Lundberg, +46 920-491748	Trafikverket	Completed
Ultrasonic measurements of internal cracks in manganese crossings	Prof Jan Lundberg, +46 920-491748	Trafikverket	Completed
Infrastructure Winter ability analysis	Dr Ulla Juntti, +46 920-491991	UIC	Completed
Maintenance performance indicators (MPIs) for Swedish Rail Administration	Prof Uday Kumar, +46 920-491826 Dr Aditya Parida, +46 920-491437 PhD candidate: Thomas Åhren 2008 – Doctoral Thesis	Trafikverket	Completed
Design for/out maintenance	Prof Uday Kumar, +46 920-491826 Dr Håkan Schunnesson, +46 920-491696 PhD candidate: Stefan Niska 2008 – Doctoral Thesis	Trafikverket	Completed
LCC analysis of Railway Switches and Crossings (S&C).	Prof Uday Kumar, +46 920-491826 PhD candidate: Arne Nissen 2009 – Doctoral Thesis	Trafikverket	Completed

Research

Project	Project members	Sponsor	Status
Maintenance strategy for railway infrastructure	Prof Uday Kumar, +46 920-491826 PhD candidate: Ulla Espling (Juntti) 2007 – Doctoral Thesis	Trafikverket	Completed
Condition based maintenance strategy for railway systems	Prof Uday Kumar, +46 920-491826 PhD candidate: Robert Lagnebäck	Trafikverket, LKAB	Completed
Reliability analysis and cost modelling of degrading systems	Prof Uday Kumar, +46 920-491826 PhD candidate: Saurabh Kumar 2008 – Doctoral Thesis	Trafikverket/JVTC	Completed
Improved train punctuality through improvement in engineering systems	Prof Uday Kumar, +46 920-491826 PhD candidate: Rikard Granström 2008 – Doctoral Thesis	Trafikverket, EU-structural funds	Completed
Improved punctuality through effective maintenance management	Prof Uday Kumar, +46 920-491826 Per-Anders Akersten PhD candidate: Birre Nyström, 2008 – Doctoral Thesis	Trafikverket, EU-structural funds	Completed
Department of Civil, Environmental and Natural resources engineering / Division of Structural and Construction Engineering			
Sustainable Bridges	Prof Lennart Elfgren, +46 920-491360	EU/UIC	Completed
Mainline	Prof Lennart Elfgren +46 920-49 3660	EU	Active
Increased Axle Loads on Railway Bridges	Dr Thomas Blanksvärd, +46 920-491642	LKAB/HLRC	Active
Design Performance	Dr Björn Täljsten, +46 920-493360	Formas	Active
Assessment of Bridge Condition	Prof Lennart Elfgren, +46 920-491360 Ulf Ohlsson/Natalia Sabourova +46 920-491853	Formas	Active
Assessment of Vindelälven Bridge	Martin Nilsson/Ola Enochsson, +46 920-492533	Trafikverket	Active
Assessment of Långforsen Bridge	Martin Nilsson/Ola Enochsson, +46 920-492533	Trafikverket	Active
Assessment of Byskeälv Bridge	Lennart Elfgren/Ola Enochsson, +46 920-491360	Trafikverket	Completed
Sustainable Renovation	Björn Täljsten/Jonny Nilimaa, +46 920-493360	Formas/Trafikverket	Active
Kiruna Mine Bridge	Mats Emborg/Ola Enochsson, +46 920-491348	LKAB	Active
Department of Civil, Environmental and Natural resources engineering / Division of Mining and Geotechnical Engineering			
Rock Mechanics Consequences of Fire in Tunnels	Prof Erling Nordlund, +46 920-491335 PhD candidate: Kristina Larsson, +46 920-492913	Trafikverket	Active
Structural Sound	Prof Erling Nordlund, +46 920-491335 PhD candidate: Andreas Eitzenberger + 46 920-492267 2008 - Licentiate Thesis 2013 – Doctoral thesis	Trafikverket	Active
Deformation and failure of hard rock	Prof Erling Nordlund, +46 920-491335 PhD candidates: David Saiang, +46 920-491053 Perez, Kelvis	Trafikverket	Active
Department of Engineering Sciences and Mathematics/Division of Machine Elements			
A pre-study on wheel/rail interface friction management	Dr Braham Prakash, +46 920-493055 Dr Jen Hardell, +46 920-491774	Trafikverket/JVTC/ LKAB	Completed
Surface Roughness and rail grinding	Dr Jens Hardell +46 920-491 000	Trafikverket	Completed
Department of Business Administration, Technology and Social Sciences/Division of Business Administration and Industrial Engineering			
Improved condition assessment through statistical analysis	Prof Bjarne Berquist, +46 920-492137	Trafikverket/JVTC/ LKAB/Infranord	Active
Department of Business Administration, Technology and Social Sciences/Division of Social Sciences			
Teknikhistoria Elektrifiering av Malmbana	Roine Wiklund	Trafikverket	Completed

Events

JVTC 15-Year Celebration

JVTC celebrated 15 years as a research center at Luleå University of Technology on December 4th, where the JVTC stakeholders together with international participants from the dissemination of EU-project AUTOMAIN, were invited. The event consisted of a celebratory dinner with entertainment. Two honorary awards for outstanding contributions to JVTC´s work were given to Prof. Lennart Karlsson and Dr. Ulla Juntti . An informative film regarding the research performed within JVTC was produced and shown during the occasion.

From left to right: Johan Sterte, Vice Chancellor, Luleå University of Technology, addressing JVTC stakeholders together with international participants during inaugural celebration

Professor Lennart Karlsson (left) and Dr. Ulla Juntti (Right) receiving citation and awards for outstanding contributions to JVTC´s research and development activities from Lennart Elfgren, Vice Chairman JVTC

International Conferences & Seminars

JVTC seminar on Integrated Health Management for automotive and railway system

Professor Nalinaksh Vyas from Indian Institute of Technology, Kanpur, India delivered a seminar on 31st May, 2013 on the topic“ Integrated Health Management for automotive and railway system”.

Professor Nalinaksh Vyas

JVTC Railway Seminar

JVTC arranged a railway seminar on the 18th of September where professor Anders Ekberg from Chalmers University of Technology presented “Railway damage epidemics – examples of causes, consequences and means of mitigation with focus on mechanical fatigue”, professor Peter Veit from University of Grantz in Austria talked about “From Life Cycle Costing to Life Cycle Management” and professor Pra Murthy from University of Queensland in Australia presented “Game theoretic approach to railway maintenance outsourcing”.

International Railway Research Collaboration & Network

To strengthen research and education stance and quality, a strong network with all related and active research groups, nationally and internationally is essential. Keeping this in view, we have created formal and informal networking and collaboration with research groups in the following universities and industries outside Sweden.

Universities: Aalto University of Technology, Finland; Birmingham University, UK; Central Queensland University at Gladstone, Australia; Indian Institute of Technology (IIT) Bombay and Kharagpur, India; Kemi Tornio University of Applied Science, Finland; Queensland University of Technology, Brisbane, Australia; Tromsö University, Norway; University of Cincinnati, USA; University of Queensland, Australia; University of Stavanger, Norway; University of Toronto, Canada; VTT, Helsinki, Finland; University of Valencia, Spain.

Industries: Airbus, France; ALSTOM Transport, France; The Division of Operation and Maintenance is one of the initiating members of the European Research Network on Strategic Engineering Asset Management (EURNSEAM). JVTC are having close collaboration into the area of reliability engineering, operation and maintenance management with the faculty at IIT Bombay. In relation to this, Prof. A. K. Verma is a Guest Professor at the Division of Operation and Maintenance, Luleå University of Technology.

JVTC participate in the work of the **Forum for Innovation in the transport sector** that has the overall goal of breaking the link between greenhouse gas emissions and transport work while maintaining or strengthening competitiveness for Sweden. Researchers from JVTC have contributed to several of Forum roadmaps.

JVTC cooperates with NorJeTS (Norut in collaboration with the University of Narvik) in the Interreg funded project **NoRRTeC** (Northern Railway Research and Test Collaboration) with the objectives to:

- establish opportunities to develop innovative technical solutions to improve reliability and reduce maintenance cost on the Iron Ore line
- build up a joint Norwegian-Swedish railway technical competence center
- a platform for collaboration and knowledge exchange with national and international partners
- build skills and find practical research issues for further work in the areas of track forces and strengthening of structures/infrastructures for high axle loads and cold climates.

JVTC is an active member of **EURNEX**, a European platform where researchers interact and influence the EU's R & D focus. EURNEX also provides the possibility to create networks for EU project applications.

Professor Uday Kumar and Prof. Diego Galar visited the **World Bank** during 2013 that resulted in new contacts in the field of transport.

University of Queensland Australia

Professor Pra Murthy from the University of Queensland, Brisbane, Australia is a Guest Professor at the Division of Operation & Maintenance Engineering, Luleå University of Technology. He has been actively participating in teaching post graduate courses and conducting workshops and seminars since the year 2009.

Center for Intelligent Maintenance System

The Div. of Operation & Maintenance Engineering is having close collaboration in maintenance area with the Center for Intelligent Maintenance Systems at University of Cincinnati, USA. In order to strengthen the collaboration, University of Cincinnati has invited Prof. Uday Kumar as a Guest Professor. Professor Jay Lee, Director IMS is also a visiting Guest Professor at the Division of Operation & Maintenance Engineering, Luleå University of Technology.

Doctorate & Licentiate Degree Awardees

Iman Arasteh Khouy

Doctoral thesis on ”Cost-Effective Maintenance of Railway Track Geometry: a shift from Safety Limits to Maintenance Limits”. In this research, a decision support tool to optimize track geometry maintenance is developed. It provides two new approaches to analyse the geometrical degradation of turnouts due to dynamic forces generated from train traffic. It also presents two cost rate functions to specify the optimal inspection interval and the cost-effective maintenance limits for track geometry maintenance (tamping).

Andreas Eitzenberger

Doctoral thesis on “Wave propagation in rock and the influence of discontinuities”. In this research focus has been on the propagation of train-induced vibrations in discontinuous rock masses through the use of numerical analyses.

Stephen Famurewa

Licentiate thesis on “Increased railway infrastructure capacity through improved maintenance practices”. In this research focus has been on studying the opportunities which maintenance presents towards enhancing the capacity of existing railway infrastructure. Outsourcing aspect of maintenance organization has been studied and a conceptual framework to facilitate the implementation of performance based maintenance contracting is proposed.

Jonny Nilimaa

Licentiate thesis on “Upgrading concrete bridges: post-tensioning for higher loads”. In this research a new method for post-tensioning for concrete bridges for higher loads has been proposed.

Publications

Journals Papers

1. Arasteh khouy, I., Larsson-Kråik, P-O., Nissen, A., Juntti, U., and Schunnesson, H. (2013). Optimisation of track geometry inspection interval, Published in Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit.

2. Arasteh khouy, I., Larsson-Kråik, P-O, Nissen, A., Lundberg, J. and. Kumar, U. (2013). Geometrical degradation of railway turnouts - A Case Study from a Swedish heavy haul railroad, published in Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit.

3. Arasteh khouy, I., Schunnesson, H., Juntti, U., Nissen, A. and Larsson-Kråik, P-O. 2013. Evaluation of track geometry maintenance for a heavy haul railroad in Sweden - A Case Study, Published in Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit.

4. Cremona, C., Eichler, B., Johansson, B. & Larsson, T. 2013. Improved assessment methods for static and fatigue resistance of old metallic railway bridges, Journal of Bridge Engineering. 18, 11, s. 1164–1173 10 s.

5. Famurewa, S. M., Asplund, M., Galar, D. & Kumar, U. 2013, Implementation of performance based maintenance contracting in railway industries, International Journal of Systems Assurance Engineering and Management. 4, 3, s. 231-240 10 s.

6. Famurewa, M. S., Xin T., Rantatalo, M., Kumar, U. 2013. Optimization of maintenance track possession time: a tamping case study, Proceedings of the Institution of Mechanical Engineers. Part F: Journal of Rail Rapid Transit.

7. Galar, D., Kumar, U., Villarejo, R. & Johansson, C-A. 2013. Hybrid prognosis for railway health assessment: an information fusion approach for PHM deployment. PHM2013: 2013 Prognostic and System Health Management: Milan 8-11 September 2013. Zio, E. & Baraldi, P. (red.). AIDIC Servizi S.r.l., Vol. 33, s. 769-774 6 s. (Chemical Engineering Transactions; Nr 33).

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1. Arasteh khouy, I. 2013 Cost-effective maintenance of railway track geometry: a shift from safety limits to maintenance limits Luleå: Luleå tekniska universitet. (Doctoral thesis / Luleå University of Technology).

2. Eitzenberger, A. 2013 Wave propagation in rock and the influence of discontinuities. Luleå: Luleå tekniska universitet. (Doctoral thesis / Luleå University of Technology).

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1. Famurewa S. M. & Asplund M. (2013). Increased railway infrastructure capacity through improved maintenance practices

2. Lin J, Using Integrated Reliability Analysis to Optimise Maintenance Strategies – A Bayesian Integrated Reliability Analysis of Locomotive Wheels. Published by: Luleå University of Technology. ISSN: 1402-1528; ISBN: 978-91-7439-600-3 (tryckt); ISBN: 978-91-7439-600-3 (pdf). 2013, May

3. Stenström, C & Parida, A 2013, Link and Effect Model for Maintenance of Railway Infrastructure, ISBN 978-91-7439-724-6, Luleå University of Technology

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5. AUTOMAIN reports:
- D4.1 Improvement analysis for high performance maintenance and modular infrastructure.
- D 4.2 Optimised maintenance activities like, grinding, tamping and other maintenance processes
- MS6 Guidance for implementing high performance maintenance
- D3.2 Modular, Self-Inspecting Infrastructure

D=deliverables, MS= Milestone

6. SUSTRAIL reports:
- D5.5: Interim Business Case Synthesis Report to Guide WP3 and WP4

7. BGLC - Bothnia Green Logistics Corridor reports:
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Key note/ Invited Speech

1. Diego Galar, 2013. Hybrid Prognosis for railway health assessment: an informant fusion approach for PHM deployment. PHM2013: 2013 Prognostic System Health Management: Milan 8-11 September 2013. Zio, E, & Baraldi, P. (red). AIDIC Servizi S.r.l., Vol.33, s.769-774 6 s. (Chemical Engineering Transactions; Nr33)

2. Per-Olof Larsson Kråiik delivered key note address on Condition Monitoring of Railway systems – Title: "How to get an Oscar". Swedish Centre for Innovation and Quality in the Built Environment AGM, 12th Mars, In Swedish "FIA Dagen" .

3. Per-Olof Larsson Kråiik delivered Key note Adress to The 10th International Heavy Haul Association Conference, hosted jointly by International Heavy Haul Association (IHHA) and Indian Railways at New Delhi, India from 4 to 6 February 2013.

4. Alireza Ahmadi invited key note 3rd International Conference on Recent Advances in Railway Engineering (ICRARE-2013), Iran university of science and Technology – Tehran – I.R. Iran –Apr 30, May 1, 2013. Title: Optimum Failure Finding Inspection DuringExtended Operation Life Key note

5. Behzad Ghodrati -Invited key note 3rd International Conference on Recent Advances in Railway Engineering (ICRARE-2013), Iran university of science and Technology – Tehran – I.R. Iran –Apr 30, May 1, 2013. Title: Reliability Analysis of Switches and Crossings in Swedish Railway

Conference Papers

1. Arasteh khouy, I., Larsson-Kråik, P-O, Nissen, A., and. Kumar, U. Feb 2013, Geometrical degradation of switches and crossings on a Swedish heavy haul railroad : a case study, study. In: Proceedings of 10th International Heavy Haul Association Conference, New Delhi, India, s. 26-32 s.

2. Asplund, M., Gustafsson, P., Nordmark, T., Rantatalo, M., Palo, M., Famurewa, M.S., Wandt, K. (2013). Automatic laser scanning of wheel profiles: condition monitoring to achieve greater capacity for existing infrastructure in an extreme climate. In: International Heavy Haul Association Conference, New Delhi.

3. Asplund, M., Larsson, D., Rantatalo, M., Nissen, A., Kumar, U. (2013). Inspection of railway turnouts using cameras. In: World Congress on Railway Research (WCRR) Australia, Sidney.

4. Galar, D., Villarejo, R., Johansson, C-A., Kumar, U. & Berges, L. 20 jun 2013, Hybrid models for PHM deployment techniques in railway. International Conference on Condition Monitoring and Machinery Failure Prevention Technologies jun. 18 2013 - jun. 20 2013. Krakow, Polen.

5. Famurewa, S. M., Xin T., Rantatalo, M. & Kumar, U. (2013). Comparative study of track geometry quality prediction models. In: 10th International Conference on Condition Monitoring and Machinery Failure Prevention Technologies. June 18-20, 2013, Krakow, Poland.

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8. Nilimaa, J., Blanksvärd, T., Täljsten, B., Elfgren, L., Carolin, A. & Paulsson, B. jan 2013, Extended Life of Railway Bridges. Results from EC-FP7-project MAINLINE, Assessment, Upgrading and Refurbishment of Infrastructures: IABSE Conference Rotterdam 2013. Van Bogaert, P. (red.). Zürich: International Association for Bridge and Structural Engineering, Kap. D3: Modernisation and Refurbishment. FRP Repair, s. 314-315 2 s. (IABSE Report; Nr 99).

9. Palo, M., Galar, D., Nordmark, T., Asplund, M. & Larsson, D. Wheel/rail condition monitoring to support rolling stock maintenance actions. 2013 Proceedings of 10th International Heavy Haul Association Conference. 8 s.

10. Rodríguez, E., Galar, D., Niska, S. & Karki, N. R. 2013. Simulation of electrical power supply system in railway infrastructure. Integration with rolling stock in Sweden. In: 5th International Conference on Power & Energy Systems: Advances in Power Systems, October 20-30, 2013, Kathmandu, Nepal.

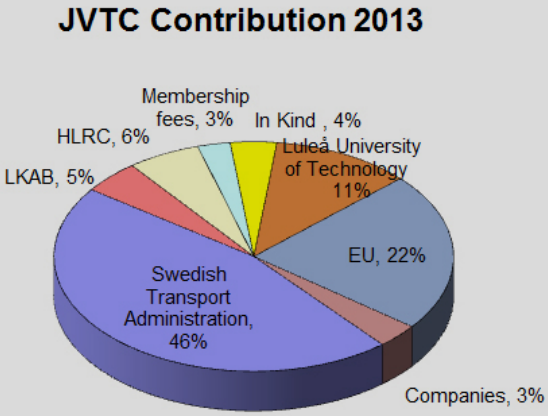
11. Rodríguez, E., Karki, N. R., Galar, D., Valderas, D. & Niska, S. 2013. Fault detection of Railway EMC problems using MATLAB models. In: International Conference on Condition Monitoring and Machinery Failure Prevention Technologies (CM 2013 and MFPT 2013 – BINDT), June 18-20, 2013, Cracow, Poland.

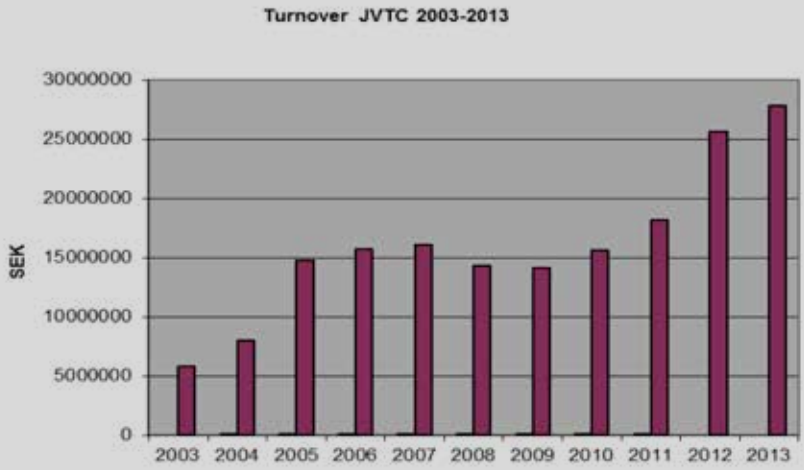
12. Rodríguez, E., Simón, V., Galar, D. & Niska, S. 2013. Dependability issues of Track Circuits - A hybrid approach. In: Second International Conference on Railway Technology: Research, Development and Maintenance. April 08-11, 2014, Ajaccio, Corsica, France.

Results 2013

JVTC has successfully been growing during the last 15 years, the financial turnover of 28 MSEK for the year 2013.

JVTC Management and Administration 2013	SEK
Membership fees	939 759
Funding from JVTC framework	500 000
Operation and Maintenance	25 000
TOTAL INCOME	1 464 759
Salaries personnel	539 113
Other personnel costs	17 118
IT/Computers	163 184
Materials	33 936
Travel	150 556
Consultants	136 868
Other operating costs	187 466
OH 225 593	
TOTAL EXPENSES	1 453 833
RESULTS JVTC	10 926
JVTC projects Luleå University of Technology	27 858 689
TOTAL	27 858 689





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