Publication 0501

# Annual Report 2003–2004


KTH
VETENSKAP
OCH KONST

Järnvägsgruppen

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# The Railway Group KTH 2003–2004

By the end of 2004 the KTH Railway Group ended its 9th year as a centre of Excellence in Railway Engineering. During 2003-2004 four Doctoral degrees and eight Licentiate of Engineering degrees have been submitted. Together with 14 masters thesis, several text books on railway related issues and approximately 100 different publications the overall scientific production is solid. The ambition to publish more journal papers is starting to pay off although this is not a very common procedure in many fields of railway engineering.

In 2004 the European Network of Excellence in Railway Research EURNEX within FP6 commenced its activities. KTH is active in the Work Package dealing with training and education and we are acting as one of the triggers for the formation of a Rolling Stock Reserach pole. We do not yet know the outcome of EURNEX but we hope to establish interesting new collaborations with other European Research Groups.

The deregulation of the Swedish railways has formed new companies with in some cases new owners. As a consequence funding of research has not been the number one priority for most of these companies. However during 2003-2004 the railways have rediscovered the importance of research as an essential part of the railway market. Funding of rail research is still a tough task but the awakening of the railways is a fact that makes the future more bright for the KTH Railway Group.

Stefan Östlund
Director

# 1. Organisation

The Railway Group KTH is organised as an independent unit within the Department of Vehicle Engineering. The board of the Railway Group consists of representatives from companies or organisations that have signed the general agreement.

## 1.1 Board 2003

**Nils Edström** (chairman) Swedish National Rail Administration (Banverket), Tel:+46 243 44 56 25, Fax:+46 243 44 54 63, e-mail: nils.edstrom@bv.se
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## 1.2 Board 2004

**Henrik Tengstrand** (chairman) Bombardier Transportation Sweden AB, Tel: +46 21 31 70 00
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# 2. Members of the Railway Group

The Railway Group KTH consists of eight research groups each representing different parts of the railway system. Below is given a brief presentation of each group and its contribution to railway education and research.

## 2.1 Railway Technology (Dept of Vehicle Engineering)

The activities at the Division of Railway Technology mainly focus on rail vehicles and their dynamic interaction with the track. Research is also carried out on topics like sound and vibrations from a railway passenger perspective, and on energy consumption and running times. In addition, the division is responsible for two undergraduate courses and several external courses.

**Personnel**

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**Undergraduate Courses**

Railway systems and rail vehicles: 6 credits / 9 ECTS credits (4B1304, 4B4304)
Rail vehicle dynamics: 5 credits / 7.5 ECTS credits (4B1313, 4B4313); the course is given in English

**Research Projects**

**1. Running gear for freight wagons (SAMBA 1)**
Research leader: Evert Andersson
Scientist: Sebastian Stichel
Graduate student: Per-Anders Jönsson
Sources of funding: Banverket, Bombardier Transportation, SL, SJ, Green Cargo

The European standardised designs of freight wagons and their running gear are 40 – 50 years old. To increase competitiveness of freight transport on rail it is desired to increase axle load and/or speeds, but this would – at least for some operating conditions for standard running gear – mean to exceed existing limit values for ride qulity and wheel-rail forces. At least as important is to improve ride qualities in order to reduce damages on transported goods and being able to attract

customers that require transport service for sensitive and high-value goods.

The project is firstly aimed to study and learn how freight wagons behave dynamically on track. This is made both for standardised running gear and for novel designs. The second step is to analyse and test possible improvements in the designs, in particular the standardised designs now dominating in the European rail freight traffic. In the project special attention is given to the very common link suspensions, their characteristics and the possible effects on variations in the characteristics. Substantial improvements by means of additional hydraulic dampers have been suggested and tested on modified two- and four-axled wagons on track. Speeds up to 170 km/h have been tested.

A third part of this project is to investigate the causes of track deterioration and to propose mathematical models for prediction of deterioration.

The project is running and is expected to continue at least to 2007.


Jönsson P-A and Stichel S: *Freight wagon running gear for higher speed – Upgrading of standard running gear (in Swedish: Godsvagnslöpverk för högre hastighet - Uppgradering av standardlöpverk)*, Elfte Nordiska Seminariet i Järnvägsteknik, Copenhagen, 31 March and 1 April 2003.

Bergstedt R: *New technology for freight trains – Possibilities and problems (in Swedish: Ny teknik för godståg - Möjligheter och problem)*, Elfte Nordiska Seminariet i Järnvägsteknik, Copenhagen, 31 March and 1 April 2003.

Stichel S: *Zum Einfluss der Strukturflexibilität des Untergestells auf das Laufverhalten von Güterwagen*, ZEV+DET Glas. Ann., Nr. 6/7, pp 270-276, 2003.

Thomas D: *Development and verification of a multibody dynamic simulation model for a freight wagon with Powell Duffryn TF25A running gear*, Studienarbeit, TRITA AVE 2003:19, KTH Railway Technology, 2003.

Jönsson P-A: *Running gear for higher axle loads and speed (in Swedish: Löpverk för högre axellast och hastighet)*, In report from the KTH Railway Group project on Efficient train systems for freight transportation.

Stichel S: *Increased axle loads with respect to track deterioration (in Swedish: Ökade axellaster med hänsyn till spårnedbrytning)*, In report from the KTH Railway Group project on Efficient train systems for freight transportation.

Bergstedt R: *Technology for efficient rail freight transportation – Automatic couplers, brake systems, distributed traction, intelligent information systems.* Report, KTH Railway Technology, 2004.

Andersson E: *Can track access charges be based on the track deterioration of different vehicles? (in Swedish: Kan banavgifter sättas efter olika fordons spårnedbrytning?)*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Stichel S: *Possibility for prediction of track deterioration by means of vehicle dynamics simulation (in Swedish: Möjlighet till prediktering av spårnedbrytning med hjälp av fordonsdynamisk simulering)*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Jönsson P-A and Stichel S: *Experimental and theoretical analysis of freight wagon link suspension*, 21st Int. Congress on Theoretical and Applied Mechanics, Warsaw, 15-21 August 2004.

Jönsson P-A and Andersson E: *Influence of link suspension characteristics on freight wagon lateral dynamics*, 6th Int. Conf. on Railway Bogies and Running Gears, Budapest, 13-16 September 2004.

Jönsson P-A: *Modelling and laboratory investigations on freight wagon link suspensions with respect to vehicle-track dynamic interaction,* Licentiate Thesis, TRITA AVE 2004:48, KTH Railway Technology, 2004.


### 2. Wear on wheels and rails (SAMBA 2)

Research leader: Mats Berg
Graduate student: Roger Enblom
Sources of funding: Banverket, Bombardier Transportation, SL, SJ, Green Cargo

During the period 2003-2004 the concept of vehicle dynamics simulations for prediction of wheel and rail wear has been further developed. Braking simulations have been introduced in order to represent wear contributions from disc och electro-mechanical braking in a more realistic way. Non-dry contact conditions can be better described in the simulations due to non-dry wear and friction measurements in laboratory. As vehicle case studies the commuter vehicle X10 and the high-speed tilting train X2000 have been studied with good agreement between simulated and measured wheel wear. A track case study is going on for curves at Älvsjö and at Tvärbanan. For both wheel and rail wear simulations we compare our methodology with simpler approaches, e.g. to relate the wear to energy dissipation. Roger Enblom completed his Licentiate degree during 2004.

The overall aim of the project is to improve the knowledge on how wheels and rails wear over time as functions of vehicle design, track geometry and operational conditions. With relevant wear models and vehicle dynamics procedures, different actions on wear and cost reductions can be suggested already from computer simulations. For instance, choice of initial wheel and rail profiles along with different turning and grinding strategies can be proposed. Vehicle based vs. track based lubrication is another practical topic that the project can support. Thus simulations of successive wheel and rail wear, and how the vehicle-track interaction is changed, have large potential on efficient optimisation of different railway systems.

The project is continuing for at least 2005 and 2006.


Enblom R and Berg M: *Simulation of wheel profile development due to wear – Influence of disc braking and contact environment*, 6th Int Conf on Contact Mechanics and Wear of Rail/Wheel Systems (CM2003), Gothenburg, 10-13 June 2003. Also published in extended form in Wear, Vol 258, pp 1055-1063, 2005.

Dirks B: *Vehicle dynamics simulation of wheel wear for Swedish high-speed train X2000,* M.Sc. Thesis, TRITA AVE 2003:16, KTH Railway Technology, 2003.

Enblom R: *Prediction of wheel and rail wear – A literature survey*, Report, TRITA AVE 2003:27, KTH Railway Technology, 2003.

Enblom R and Berg M: *Predictions of successive rail wear by vehicle-track dynamic simulations – General procedure and application to a railway for Stockholm commuter traffic*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Enblom R: *Simulation of wheel and rail profile evolution – Wear modelling and validation*, Licentiate Thesis, TRITA AVE 2004:19, KTH Railway Technology, 2004.

Enblom R and Berg M: *Towards calibrated wheel wear simulation – A comparison between traditional approach and novel methods*, 6th Int. Conf. on Railway Bogies and Running Gears, Budapest, 13-16 September 2004.

Enblom R and Berg M: *Wheel wear modelling including disc braking and contact environment – Simulation of 18 months of commuter service in Stockholm*, 14th Int. Wheelset Congress, Orlando, Florida, 17-21 October 2004.

Berg M: *Understanding wear and profile changes of wheels and rails*, Conf on Advancing Practical Strategies for Wheel/Rail Interface Management, London, 8-9 December 2004.


### 3. Modelling of rail vehicle dynamics (SAMBA 3)

Research leader: Mats Berg
Graduate student: Nizar Chaar
Sources of funding: Banverket, Bombardier Transportation, SL, SJ, Green Cargo

During the period 2003-2004 the work in this project has focused on wheelset structural flexibility and dynamics and its effects on vehicle-track interaction in terms of ride instability, wheel-rail forces, derailment and wear with emphasis on the frequency range of 0-100 Hz. As a case study the Swedish Rc locomotive is studied, both experimentally and numerically. First its wheelsets alone were studied followed by the full vehicle-track interaction. It was found that the wheelset structural flexibility has a significant influence on the wheel-rail forces, especially for lateral forces. Also the importance of the track flexibility was demonstrated and this is now the focus in the project. Nizar Chaar completed his Licentiate degree during 2004.

The overall aim of the project is to improve the knowledge and mathematical models of the dynamics of the vehicle-track system and its components. In this way the potential of vehicle-track interaction simulations can be raised and become a very important and reliable tool in the design of new vehicles or in modifications of existing vehicles.

The vehicle impact on track and track damage can also be better understood and appropriate actions can be suggested.

The project is continuing for at least 2005 and 2006.


Chaar N and Berg M: *Structural flexibility models of wheelsets for rail vehicle dynamics – Experimental and numerical modal analyses of a loco wheelset*, Elfte Nordiska Seminariet i Järnvägsteknik, Copenhagen, 31 March and 1 April 2003.

Berg M: *Dynamics of hydraulic dampers – Measurements and modelling*, Elfte Nordiska Seminariet i Järnvägsteknik, Copenhagen, 31 March and 1 April 2003.

Hansson J: *Reduction of flexural vibrations in rail vehicle car bodies using piezoelectric elements and passive shunt circuit*, M Sc Thesis, TRITA AVE 2003:15, KTH Railway Technology, 2003.

Jain A: *Development of MATLAB graphical user interfaces for various vehicle dynamics aspects, summer internship report*, KTH Railway Technology, 2003.

Chaar N and Berg M: *Experimental and numerical modal analyses of a loco wheelset,* 18th Int. Symp. on Dynamics of Vehicles on Roads and on Tracks (IAVSD'03), Atsugi, Kanagawa, Japan, 25-29 August, 2003.

Berg M: *Track geometry and dynamic vehicle-track intercation (in Swedish: Spårgeometri och dynamisk samverkan fordon-bana*), Banverkets spårseminarium, Helsingborg, 28 April 2004.

Chaar N and Berg M: *Vehicle-track simulation considering wheelset structural flexibility – The case study of an Rc7 loco and comparison with measurements*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Chaar N: *Wheelset structural flexibility and vehicle-track dynamic interaction*, Licentiate Thesis, TRITA AVE 2004:22, KTH Railway Technology, 2004.

Chaar N and Berg M: *Experimental and numerical modal analyses of a loco wheelset*, Journal of Vehicle System Dynamics, Supplement to Vol 41, pp 597-606, 2004.


### 4. Track stiffness and track maintenance (SAMBA 7)

Research leader: Mats Berg
Graduate student: Eric Berggren (Banverket)
Source of funding: Swedish National Rail Administration (Banverket)

The track stiffness, in particular vertically, is more and more often related to track standard and track maintenance. The main purpose of this project is to develop a methodology and a new wagon for continuous measurements of track stiffness as the wagon travels along the track. A two-axled freight wagon has been rebuilt for this purpose in close collaboration with Banverket. During 2004 various tests have been carried out on different Swedish railway lines with encouraging results. In particular, interesting findings have been achieved for tracks at rather poor soils like clay and peat. The project is also related to the EU project SUPERTRACK. Dynamics simulations have also been done in parallel to support the performance and interpretation of the measurement results, which in turn should support proper track maintenance actions.

The project is running also during the first half of 2005, and will probably continue in 2006.


Smekal A, Berggren E and Hrubec K: *Track-substructure investigations using ground penetrating radar and track loading vehicle*, Railway Engineering – 2003, London, 30 April and 1 May 2003.

Berggren E, Berg M, Jahlénius Å and Bengtsson B-E: *Simulation and development of new wagon for track stiffness measurements (in Swedish: Simulering och utveckling av ny styvhetsmätvagn),* 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.


### 5. Influence of low-frequency vibrations on passenger activities (SAMBA 8)

Research leaders: Evert Andersson, Shafiquzzaman Khan, Johan Förstberg (VTI)
Graduate student: Jerker Sundström (VTI)
Sources of funding: Banverket, VTI

This is a collaboration project between KTH and VTI (Swedish National Road and Transport Research Institute). The entire study is investigated in two phases. The first phase of the studies is completed on real train environment, whereas the second part of the studies is made at laboratory environment. The main objective of the project is to investigate the effects of vibrations on the performance of various sedentary activities like reading, writing, drinking, computer works, etc. In the first phase of the studies a questionnaire survey and vibration measurements were made aboard trains.

The second phase included laboratory studies, where the effects of low-frequency vibration (0.8 Hz to 10 Hz) on sedentary activities, namely reading and writing, are investigated in a mock-up carbody. This investigation is focused on continuous and transient vibration signals using various amplitudes and frequencies. The study is running and expected to be completed by early 2006.


Khan S M: *An attempt to reduce aboard annoying noises in passenger trains*, Proc. of Euro Noise, Paper ID 35, Naples, 2003.

Khan S M: *Effects of masking sound on train passenger aboard activities and other interior annoying noises*, ACTA ACOUSTICA, Vol 89, pp 711-717, 2003.

Förstberg J, Sundström J, Khan M S and Andersson E: *A study on the effects of low-frequency vibrations on writing and reading in a train environment*, UK Conference on Human Comfort, Paper No. 12, September 2003.

Sundström J: *Contextual aspects of the seated posture under vibration exposure – Examples from studies of truck drivers sitting during driving*, UK Conference on Human Comfort, Paper No. 15, September 2003.

Khan M S and Sundström J: *Vibration comfort in Swedish intercity trains – A survey on passenger posture and activities*, Int Congress on Acoustics 2004 (ICA 2004), Kyoto, 4-9 April, 2004.

Sundström J and Khan M S: *Train passengers' experience of noise and vibration – A questionnaire investigation on Swedish InterCity trains in spring 2003*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Singhai M: *Development of MATLAB graphical user interface for calculation of railway ride comfort indices, summer internship report*, KTH Railway Technology, 2004.

Sundström J and Förstberg J: *Difficulties for train passengers to read and write under lateral vibrations – Preliminary results from a laboratory study,* UK Conference on Human Comfort, Paper No. 10, September 2004.


### 6. Dynamic instability and discomfort of high-speed trains, in particular induced by aerodynamics in tunnels (SAMBA 9)

Research leaders: Mats Berg, Sinisa Krajnovic (Chalmers)
Graduate student: Ben Diedrichs
Sources of funding: Banverket, Bombardier Transportation

The main background for this project is the lateral dynamics problems encountered in Japan for some Shinkansen trains travelling through tunnels. In particular, the tail cars can oscillate heavily creating discomfort and a potential safety risk. So far no cases have been found in Europe with similar oscillating amplitudes and problems. Based on very computationally demanding aerodynamics simulations in the project, it can be concluded that the most important parameters to explain the prensent phenomena are: ratio between train cross-section and tunnel cross-section, distance from train to tunnel wall, shape of the train tail and probably also on the inter-vehicle gap and bogie shielding. The practical results of the project are guidelines on how to design vehicles and tunnels to avoid the kind of dynamics problems described above. Vehicle-track interaction analysis, including aerodynamic external loads, will be included to further support these guidelines etc. Also crosswind effects have been merged into the project lately.

The project is continuing until the spring of 2006.


Diedrichs B: *On computational fluid dynamics modelling of crosswind effects for high-speed rolling stock*, Proc Instn Mech. Engrs Vol. 217 Part F: J. Rail and Rapid Transit, pp. 203-226, 2003.

Diedrichs B, Berg M and Krajnovic S: *Dynamic instability and discomfort of high-speed trains, in particular induced by aerodynamics in tunnels*, Svenska Mekanikdagar, Chalmers, 13-15 August 2003. Presented by Krajnovic S.

Diedrichs B, Berg M and Krajnovic S: *Large eddy simulations of a typical European high-speed train inside tunnels*, SAE paper 2004-01-0229, 2004.

Diedrichs B, Ekequist M, Stichel S and Tengstrand H: *Quasi-static modelling of wheel-rail reactions due to crosswind effects for various types of*

*high-speed rolling stock*, Proc. Instn Mech. Engrs Vol. 218 Part F: J. Rail and Rapid Transit, pp. 133-148, 2004.

Andersson E, Häggström J, Sima M and Stichel S: *Assessment of train-overturning risk due to strong cross-winds*, Proc. Instn Mech. Engrs Vol. 218 Part F: J. Rail and Rapid Transit, pp. 213-223, 2004.

Diedrichs B, Berg M and Krajnovic S: *Dynamic instability and discomfort of high-speed trains, in particular induced by aerodynamics in tunnels*, SVEA fordonsareodynamikdag, 5 May 2004. Presented by Krajnovic S.

Diedrichs B, Berg M and Krajnovic S: *Large eddy simulations of the flow around high-speed trains cruising inside tunnels*, European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2004).

### 7. Robust safety systems for trains

Research leader: Evert Andersson
Graduate student: Dan Brabie
Sources of funding: Banverket, Bombardier, SL, SJ, Green Cargo, VINNOVA

The research project "Robust safety systems for trains" aims at systematically studying the possibilities of minimising devastating consequences of high-speed derailments by appropriate measures and features in the train design. In particular the cause of events immediately after a mechanical failure on axles, wheels, rails or similar is studied, e.g. whether the train stays upright close to the track centre or deviates laterally with probably serious consequences. Conclusions are drawn from an interactive process where multi-body computer simulations are performed and compared with real incidents and accidents. Different train design parameters are systematically investigated by means of in this way validated simulation models. Also the effects of wheels running on sleepers are studied.

The project is estimated to continue at least until 2007.

Brabie D and Andersson E: *Robust safety systems for trains – Project description and status*, Elfte Nordiska Seminariet i Järnvägsteknik, Copenhagen, 31 March and 1 April 2003.

Brabie D and Andersson E: *Robust safety systems for trains*, 12:e Nordiska Seminariet i Järnvägsteknik, Luleå, 1-2 June 2004.

Brabie D and Andersson E: *Robust safety systems for trains*, 6th Int. Conf. on Railway Bogies and Running Gears, Budapest, 13-16 September 2004.

### 8. Simulation of energy and running time of trains (SimERT)

Research leader: Piotr Lukaszewicz
Source of funding: Swedish National Rail Administration (Banverket)

The objective of the SimERT project is to:
- Develop models of trains and drivers for calcualation of power consumption, impact on environment, capacity and running time.
- Perform research on how the energy usage and running time of trains is affected in particular by the driving style and train characteristcs.
- Develop optimised driving strategies in a rail network with respect to energy usage and driving time, so called eco-driving.

Computer models of trains and drivers are developed from full-scale measurements and thereafter verified. The driver computer models can drive a train in a similar way as an average driver would do, by making use of developed driving describing parameters. It is also possible to drive in any desired way, so that optimised style of driving can be tested with respect to energy consumption, environmental impact, capacity and time table. The developed and verified models of trains and drivers are going to be implemented into computer programs simulating railway traffic.
A computer program SimERT/TTS is under development in cooperation with Banverket (Swedish National Rail Administration) and ÅF-Infrateknik.

The project will run also for the period 2005-2007.

Lukaszewicz P: *Energy saving driving methods for freight trains,* COMPRAIL 2004, Dresden, 17-19 May 2004.

Lukaszewicz P: *SimERT project – Simulation of energy usage and running time for trains*, 2nd UIC Energy Efficiency Conference, Paris, 4-5 February 2004.

### 9. Nowait Transit

Research leader: Mats Berg (KTH part)
Source of funding: Botnia Production (VINNOVA)

A new mass transit vehicle concept is proposed. On elevated guideways in big cities, very long trains with short carbodies will fold and at the same time slow down when approching stations. Passengers can exit from and enter into the cars while the trains are moving very slowly through the stations. When leaving the stations, the trains unfold and speed up again. The KTH part in the project is mainly on the mechanical train design and the train-track interaction.

### 10. Novatrain RoRo

Research leader: Evert Andersson (KTH part)
Source of funding: SEMCON (VINNOVA)

A feasibility study was made in 2004 on the possibilities to design a roll-on-roll-off (RoRo) rail freight wagon for fast rail transportation of semi-trailers and load cassettes. Also the economical feasibility was studied. The main study was performed by Semcon Sweden, while KTH provided support in matters of railway technology. Four internal reports were produced by KTH.

### 11. Efficient train systems for freight transportation

Research leader: Evert Andersson
Researcher: Sebastian Stichel
Graduate student: Per-Anders Jönsson
Research engineer: Rune Bergstedt
Sources of funding: Banverket, Vinnova, Green Cargo AB

This is a multidisciplinary project, aiming at finding means to develop the rail freight system. It is a systems study on technology, procedures market and economy.
The project includes several parts. The Division of Railway Technology has mainly participated in the parts on Intermodal transports, Dual Mode Locomotives, Vehicle-track Interaction as well as Running Gear and Braking.

Woxenius J, Andersson E, Bärthel F, Troche G, Sommar R: *A Swedish intermodal transport service based on line-trains serving freight forwarders*. World Congress of Transport Research (WCTR 2004), Istanbul, July 4-8th 2004.

Jönsson P-A: *Running gear for higher axle loads and speed.* In report from the KTH Railway Group project on Efficient train systems for freight transportation.

Stichel S: *Increased axle loads with respect to track deterioration*. In report from the KTH Railway Group project on Efficient train systems for freight transportation.

Bergstedt R: *Technology for efficient rail freight transportation – Automatic couplers, brake systems, distributed traction, intelligent information systems.* Report, KTH Railway Technology, 2004.

### 12. European Railway Research Network of Excellence (EURNEX)

Research leader: Stefan Östlund (KTH part)
Scientist: Mats Berg
Source of funding: European Commission
This EU project for 2004-2007 aims at creating a network of excellence for railway research and education. About 65 universities and institutes all over Europe participate in this project. So far the KTH work has mainly focused on integrating education and training efforts in railway engineering among different European countries. In 2005-2007 formulation of, and application for, common research projects will also be part of the KTH contribution. The EURNEX project is carried out in close collaboration with railway administrations, operators and manufacturers.

## 2.2 Transportation and logistics (Dept of Infrastructure)

The train traffic group has special competence in the areas of market, railway operation and economy. Examples are traffic planning, customer preference valuations, forecast models, market analysis for both passenger and freight, capacity simulation models and infrastructure planning.

### Personnel

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| | Anders Lindahl | lindahl@infra.kth.se |
| | Olov Lindfeldt | olovl@infra.kth.se |
| | Sofia Lundberg | sofia@infra.kth.se |
| Research Engineers | Torleif Jansson | tleif@infra.kth.se |

#### UNDERGRADUATE COURSE

Rail Traffic Planning: 5 credits (1H1206)
For Linköping University: Planning for surface transportation (TNK048; until 2004)

#### POSTGRADUATE COURSE

Methods for Rail Traffic Planning: 5 credits (F1N5200)

#### RESEARCH PROJECTS

**1. Efficient Train Systems for passenger trains**
Research leader: Bo-Lennart Nelldal
Scientists: Karl Kottenhoff, Gerhard Troche
Sources of funding: Swedish National Rail Administration (Banverket) and regional authorities
In Efficient Trains Systems the department of traffic and transport planning works with issues concerning effectiveness, attractiveness and evaluation methods for forecasts and cost/benefit analyses. Trains are seen as a mean to strengthen the social economy, reduce the environmental impact from traffic and to give better quality of life.

Nelldal B-L., Troche G: *Utveckling av utbud och priser på järnvägslinjer i Sverige 1990-2003*, september 2003.

Troche G: *Priser för tågbiljetter i Europa – Med exempel på prissystem från Deutsche Bahn*, november 2003.

Nelldal B-L, Troche G (2003): *Europakorridoren – Utbud, prognoser och samhällsekonomi*. TRITA-INFRA 03-052.

2.2.1 Kottenhoff, K, *Evaluation of passenger train concepts – practical tools for measuring travellers' preferences in relation to costs*, Verkehrstage in Dresden Sept.2003

**2. Passenger boarding and flows in trains / TRAINLAB 7**
Research leader: Karl Kottenhoff
Scientist: Wiktoria Heinz
Sources of funding: Railway Group KTH
The project is a continuation of the pilot study on efficient train systems. The most important parts of the project deal with passenger flows boarding and de-boarding railway cars. The project contains measurements of boarding and de-boarding times of different train-types and development of a model to define the most important factors.

Heinz, W (2003): *Passenger service times on trains, Theory, measurements and models.* TRITA-INFRA03-62. Licentiate Thesis

**3. Track system for flexible train operation – analyses of different operation principles and the interaction with rail infrastructure**
Research leader: Bo-Lennart Nelldal
Scientist: Anders Lindahl and Torleif Jansson
Sources of funding: Swedish National Rail Administration (Banverket)
The Railway Group KTH has in the project "Efficient train-system" made analysis of future operating-principles with new vehicle concepts. The principal is to have many small trains instead of few long trains, where some trains go direct and other stops at more stations. New prerequisites for traffic and tracks will also bee introduced in freight traffic by linear combi, long freight trains and high speed freight trains.
This concludes that the market and the traffic will put new and variable demand for infrastructure and that it will be desirable to have a sustainable infrastructure, making flexible traffic-systems possible. The objective of this project is to analyse in RailSys different traffic-principles and the construction of the infrastructure to get as much as possible of flexibility and as little as possible of delays.

Jansson T, Wahlborg M: *Final report Capacity calculations Sweden – UIC Capacity management 3*. Banverket-KTH 2004-04-23

**4. Future infrastructure and train run quality**
Research leader: Bo-Lennart Nelldal
Scientist: Olov Lindfeldt
Source of funding: Swedish National Rail Administration (Banverket)

This project has two major parts: capacity dimensioning of single-track railways and capacity dimensioning of great railway junctions. The punctuality, i.e. delay distributions, and train run quality are important factors in both parts. The two parts together will form a Ph.D.-thesis. For single-track railways two different types of infrastructure are analysed:
• Single-track with short twin-track sections in order to obtain time efficient and robust crossings.
• Single-track with only ordinary crossing stations.
These infrastructure variants are analysed with analytical (statistical) methods and with simulations in RailSys. A comparison between the variants is made for overall capacity, travelling times and robustness. For great junctions the value of parallel movements is estimated. Both analytical methods and simulation are used.

**5. Model for supply and demand on rail freight transport**
Research leader: Bo-Lennart Nelldal
Scientist: Gerhard Troche, Sofia Lundberg
Sources of funding: Swedish National Rail Administration (Banverket) and Green Cargo (Swedish State Freight Railways)
The aim of the project is to develop a production model that describes the freight transport system on railways as well as a model that describes the customers preferences that are important in the choice between transport solutions for long distance freight transports as function of the offer.
The supply and cost model is a model which can be used to evaluate different production systems. The supply and cost model includes three levels: The consignments, the trains and the infrastructure. With the model it is possible to evaluate existing systems as well as future hypotetical systems.
The other project deals with the customers valuation of different factors in the supply as time, delays, frequence and price. Stated Preferences interviews have been made by transport managers and analyses will be done of the importance of different factors.

**6. Efficient train systems for rail freight transportation – a system study**
Research leader: Bo-Lennart Nelldal
Scientist: All members of KTH Railway Group, Peter Bark (TfK) and Jakob Wajsman (Banverket)
Sources of funding: Swedish National Rail Administration (Banverket) and Vinnova.
This is an interdisciplinary study involving all members of the Railways group. The idea is examine the railway as a system both from the market and from the technical point of view, competing and cooperating with other modes. The objective of the study is to describe how the future rail freight transportation system can be designed depending on the technical development potential of the railway, the market and the customers demand and preferences.
The critical factors will be defined from the point of view of the market and the railways possible future performance on basis of available technical solutions and how it can be used in different products

for example in wagon-load systems for heavy transports, inter-modal systems and high speed freight systems. An evaluation will be done of different products from business point of view. A forecast of the consequences of implementation of the ideas for efficient freight train systems on the transport market in Sweden will be done in the perspective of the year 2020. Finally, some important strategical factors that is relevant for further research and development will be described.


Nelldal B-L: *Intermodala transporter och framtida terminaler*. Seminarium Näringsdepartementet 2003-03-12.

Nelldal B-L., *Effektiva tågsystem för godstransporter – En systemstudie*. Sammanfattning. Järnvägsgruppen KTH 2004-11-09.


### 7. Car ownership model

Research leader: Bo-Lennart Nelldal
Scientist: Oskar Fröidh and Staffan Algers (Transek AB). From Transek AB also Isak Jarlebring and Joakim Köhler
Sources of funding: Swedish National Rail Administration (Banverket)
Access to a car is an important factor for choice of mode for travelling. In the national forecast system Sampers an older car ownership model is implemented, which especially for urban areas with good public transport supply have proved to be inaccurate. This project has the aim to develop a new car ownership model based on accessibility measures and with respect to the public transport supply for different regional structures.

### 8. Introduction of regional high speed trains. A study of the effects of the Stockholm–Eskilstuna line on travel market, travel behaviour and accessibility.

Research leader: Bo-Lennart Nelldal
Graduate student: Oskar Fröidh
Sources of funding: Swedish National Rail Administration (Banverket) Vinnova, SIKA and regional authorities
Large investments are presently being made in the Swedish railway system, e.g. in the region around lake Mälaren near Stockholm. This will result in shorter travelling times and new regional commuting patterns with increasing marketing shares for the railway. There are now interesting possibilities to make research before and after the opening of the new link between Stockholm and Eskilstuna. The aim of this project has been to study customer preferences, changes in travel behaviour, living and the real estate market. One of the results of the project is that the introduction of a new railway line and new trains on the route between Stockholm and Eskilstuna has increased the number of travellers seven times the first five years, and the market share has risen from 5 to 30%.


Fröidh, O (2003): *Introduktion av regionala snabbtåg. En studie av Svealandsbanans påverkan av resemarknaden, resbeteende och tillgänglighet*. TRITA-INFRA 03-040

Fröidh, O (2003): *Introduction of regional high speed trains. A study of the effects of Svealand line on the travel market, travel behaviour and accessibility.* TRITA-INFRA 03-041. Doctoral dissertation


### 9. Establishing regional train services – a comparison between regions

Research leader: Oskar Fröidh
Sources of funding: Swedish National Rail Administration (Banverket)
This research project has the aim to improve the possibilities for regional train services in a context of urban and regional planning. The project includes analyses of different regional traffic systems with different train service supplies in regions with varying socio-economic prerequisites and labour markets. Comparisons will be made between good or poorer train services, and analyses of the importance of different supply factors for demand, traveller's knowledge and valuation of the supply of services.

The KTH Railway Group has made an extensive evaluation of the introduction of regional high-speed trains on the Svealand line. Whereas the research project about the Svealand line dealt with changes over time, this study of the market for regional train services concentrates on geographical differences between regions in Sweden.

### 10. Public transport worth its price – effects on regional commuting

Research leader: Karl Kottenhoff
Scientists: Oskar Fröidh. From ÅF: Kjell Jansson and Chris Halldin
Sources of funding: Vinnova
This project aims at showing how reduced generalised travel costs for public transport contribute to enlarging the regional labour market in the Stockholm and Mälardalen region. The following goals are important: a higher employment rate, a higher competence provision and reduced social costs. Means to reach these goals are:

- reducing travelling times
- increasing and levelling out travelling comfort for trips within Stockholm County and across the county border
- adjusting the price structure to reduce great cost differences between travelling within Stockholm County and across the border

These measures increase the accessibility and can reduce car traffic. In this way, economic growth and environmental sustainability can be promoted. The results are presented as generalised costs, regional distribution, accessibility, financial effects, externalities, social economics, social distribution effects and potential for growth. Moreover, more specific issues come to light, for example, the value of ability to work during a commute trip. The project consists of four studies:

1. A study of comfort standards and passenger valuations of comfort. This will result in a proposal for a new standard.
2. A study of the possibilities to improve the supply of public transport services.
3. An analysis of alternative fare structures
4. A simulation of improved public transport resulting in social, environmental and economic valuations

### 11. Monetary valuations of ride comfort

Research leader: Karl Kottenhoff
Scientists: Johan Förstberg (VTI) and Camilla Olsson (Transek AB)
Sources of funding: Swedish National Rail Administration (Banverket)
The purpose of this study is to quantify the train passengers' ride comfort. How much are they willing to pay for better standard? The project consists of two parts. The first part is a perception study that will show how the passengers perceive train comfort. Can they separate the comfort which derives from maintenance management? In the second study the train passengers' willingness to pay for maintenance comfort will be estimated. The project is made in cooperation between KTH, VTI and Transek AB.


Kottenhoff K, Förstberg J, Olsson C (2004), *Visst skakar det men vad märker tågresenären?*, TRITA-INFRA 04-009

Kottenhoff K, Förstberg J, Olsson C: *Monetära värderingar av åkkomfort – betalningsvilja för olika spårunderhållsnivåer, delrapport*, Forskardagar Linköping VTI, Jan 2004


### 12. Other projects


Nelldal B-L, Wajsman J: *Framtida järnvägstrafik – Prognoser för Banverkets framtidsplan och olika organisationsmodeller.* Järnvägsgruppen KTH Stockholm 2003-11-06. Bilaga till Järnvägsutredningen SOU 2003:104.

Kottenhoff K, Dziekan K, Olsson A-L: *Resenärernas attityder och prefernser till kollektivtrafik, tåg och stationer*. Järnvägsgruppen KTH Stockholm 2003-02-05. Bilaga till Järnvägsutredningen SOU 2003:104.


## 2.3 Lightweight Structures (Dept of Vehicle Engineering)

The Lightweight Structure group has a long experience in the area of lightweight designs for many different transportation means like airplanes, buses, ships etc. Within the Railway Group, the research emphasises on railway car-bodies in sandwich construction.

**Personnel**

| | | |
|---|---|---|
| Professor | Dan Zenkert Ph D | danz@kth.se |
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#### RESEARCH PROJECTS

**1. Efficient train systems for rail freight transportation/Light-weight freight cars**

Research leader Per Wennhage

A study to investigate the feasibility of lightweight structural concepts in freight cars was commenced. The study will primarly focus on safety issues.

Kolsters H, Wennhage P: *Eco-efficiency optimisations of Sandwich Railway Vehicle Components. A preliminary Study*, KTH 2003

## 2.4 Structural Design and Bridges

The division is conducting research and education within railway track engineering including bridges and tunnels. They are also responsible for co-ordination of issues concerning the railway infrastructure.

**Personnel**

| | | |
|---|---|---|
| Professor | Håkan Sundquist | hakan.sundquist@byv.kth.se |
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| | Gerard James, PhD | gerard.james@byv.kth.se |
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| | Axel Liljencrantz MSc | axel.liljencrantz@byv.kth.se |
| | Esra Bayoglu FlenerM Sc | esra.bayoglu@byv.kth.se |

#### UNDERGRADUATE COURSE

Rail Track Engineering: 5 credits (1C1206)

#### RESEARCH PROJECTS

**1. Loads and Load Influence on Structures**

Research Fellows Raid Karoumi and Gerard James

Source of Funding: Johnson Foundation, KTH, Swedish National Road Administration (Vägverket), Swedish National Rail Administration (Banverket).

The project deals with studies of the dynamic response of bridges subjected to moving vehicles. Measurement methods for loading on railway and road bridges are examined. Bridge weigh-in-motion systems including interpretation of statistical results are developed.

Sundquist H and James G: *Monitoring of shear cracks and the assessment of strengthening on two newly-built light-rail bridges in Stockholm.* In Second International Conference on Bridge Maintenance Safety and Management, IABMAS, Kyoto, Japan, October 2004.

Sundquist H and Karoumi R: *Whole life costing and degradation models for bridges*. In: ILCMI 2003, International workshop on integrated life-cycle management of infrastructures – bridges, Taipei, Taiwan, 2003.

James G: 2004, Division of Structural Design and Bridges. *Long-Term Health Monitoring of the Alvik and Gröndal Bridges,* TRITA-BKN. Rapport 76, Brobyggnad 2004 ISSN 1103-4289 ISRN KTH/BKN/R--76—SE

**2. Long-term Monitoring and Assessment of the New Årsta Railway Bridge**

Research Fellow Raid Karoumi

Graduate Student Merit Enckell-El Jemli

The aim of the project is the long-term monitoring of railway bridges. The project is designed to compare traditional monitoring techniques with the relatively new fibre optic measuring systems and assess their behaviour over long measuring periods. The project is also intended to increase the understanding of the dynamic behaviour of railway bridges.

This project uses measuring information that is described more thoroughly in the next project description

Enckell M, Karoumi R and Wiberg J: Structural Health Monitoring for an optimized pre-stressed concrete bridge. In: SHMII-1, The First International Conference on Structural Health Monitoring and Intelligent Infrastructure, Tokyo, Japan, November 13-15, 2003.

Enckell M, Karoumi R and Lanaro F: *Monitoring of the New Årsta Railway Bridge using traditional and fibre optic sensors.* In: SPIE's Symposium on Smart Structures and Materials, NDE for Health Monitoring & Diagnostics, San Diego, USA, 2-6 March 2003.

**3. A study of the dynamic interaction between train and bridge and the long-term changes in the dynamic properties of the new Årsta bridge.**

Research Fellow Raid Karoumi

Graduate Student Johan Wiberg

The New Årsta Railway Bridge in Stockholm which is under construction at this very moment is a slender and optimized railway bridge. Thus, it is a very complex prestressed concrete structure that shall be opened to traffic in 2005. Until then over 80 sensors, e.g. traditional strain gauges and fibre optic sensors for static monitoring, will be embedded into the concrete to measure strains that arise from curing concrete, dead load, traffic, wind etc. The Swedish National Railway Administration (Banverket) have initiated the measuring program to follow up stresses and deformations during construction and operation of the bridge. Two Ph.D. student projects will investigate the dynamic and static behaviour of the bridge through inspection and supervision via internet connection to the sensors, which will give a unique opportunity for research on railway bridges and particularly the interaction between train and construction. Two sections have already been installed completely with sensors and all of them are working properly.

The aim is to verify uncertainties in the structure, during construction and 10 years of service, leading to knowledge and updated codes which, in turn, will give economical and safe solutions concerning similar structures in the future.

For the static response the aim is to:

- Control the maximal strain and stresses
- Verify cracking, if any
- Report strain changes, both during construction and 10 years of service
- Compare fibre optic sensors with traditional strain gauges

For the dynamic response the aim is to:

- Evaluate the fundamental frequencies, modes and damping ratios
- Evaluate the dynamic effects of trains crossing the bridge
- Evaluate the long-term changes in the bridge's dynamic properties.

Karoumi R, Wiberg J and Olofsson P: *Monitoring traffic loads and traffic load effects on the New Arstaberg Railway Bridge*. In: International Conference on Structural Engineering, Mechanics and Computation (SEMC 2004), Cape Town, South Africa, 2004.

**4. Efficient train systems for rail freight transportation**

Research leader Håkan Sundquist

Research assistant Gerard James

**5. Sustainable bridges.**

The project is a European Community funded project that involves

the cooperation between many partners from universities, railway infrastructure owners and industry around Europe and is part of the sixth framework programme. The aim of the project is to produce guidelines and research papers to assist engineers in the evaluation of existing railway bridges. Much of the railway bridge stock in Europe is coming to an end of its originally planned service life, however, the demands on our railway bridges are constantly increasing with railway operators requiring increased allowable axle loads and increased train speeds. There is a common European need to establish new and improve existing methods for the evaluation of this ageing railway bridge stock.

Research leader Håkan Sundquist
Research Fellows Raid Karoumi and Gerard James

**6. Soil-Structure Interaction for Integral Bridges and Culverts.**

Doctoral Student Esra Bayoglu

2.4.6. Bayoglu Flener E: 2003, Division of Structural Design and Bridges. Field Study of a Long-span Arch Corrugated Steel Culvert on Skivarpsån During and After Construction – Part I, TRITA-BKN. Rapport 72, Brobyggnad 2003.

2.4.6. Bayoglu Flener. E: 2004, Division of Structural Design and Bridges. Field Testing of a Long-span Arch Steel Culvert Railway Bridge over Skivarpså: Sweden Part II, TRITA-BKN. Rapport 84, Brobyggnad 2004.

**7. Dynamic response of railway bridges on high-speed lines.**

The project investigates the dynamic response of railway bridges on high-speed lines such as those for the new Botnia line. The design speed for this line is for trains travelling at up to 300 km/h. These types of speeds may cause excessively high stresses and vibrations, if the bridge is excited at one of its natural frequencies. Another problem to be studied is that of ballast instability where the downward accelerations of the bridge deck cause the ballast to lose its resistance properties to transverse forces.

Research Fellow Raid Karoumi
Doctoral Student Johan Wiberg

## 2.5 Marcus Wallenberg Laboratory for Sound and Vibration Research (Dept of Vehicle Engineering)

The laboratory is within the Railway Group responsible for issues concerning noise and vibrations in railway engineering. The research group has a long and broad experience of the field including work on both internal and external noise.

### Personnel

| | | |
|---|---|---|
| Professor | Anders Nilsson Ph D | andersni@fkt.kth.se |
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| Researcher | Ulf Carlsson Ph D | ulfc@fkt.kth.se |
| Graduate Students | Nicolas Baron M Sc | nicolas@fkt.kth.se |

#### RESEARCH PROJECTS

**1. Effective train systems for rail freight transportation**

Scientist Ulf Carlsson

**2. Acoustical and dynamic properties of floating floors for railway coaches/TRAINLAB 4**

Graduate Student Nicolas Baron
Source of funding Railway Group KTH

This project investigates the acoustical and vibration properties of floating floors with application to railway vehicles.

## 2.6 KTH Electrical Machines and Power Electronics (Dept of Electrical Engineering)

KTH Electrical Machines and Power Electronics are performing research and education in the area of electric railway traction. That includes traction motors, traction transformers, converters and electromechanical devices for active suspension of rail cars.

### Personnel

| | | |
|---|---|---|
| Professor | Stefan Östlund Ph D | stefan@ekc.kth.se |
| Graduate Students | Staffan Norrga M Sc | staffan@ekc.kth.se |
| | Tommy Kjellquist MSc | tommyk@ekc.kth.se |

**Undergraduate course**

Electric Traction: 4 credits (2C1149)

#### RESEARCH PROJECTS

**1. Soft-switched four-quadrant converter with medium frequency transformer**

Research leader: Stefan Östlund
Graduate students: Staffan Norrga, Tommy Kjellqvist
Source of funding: Elforsk AB, Banverket

The project is concerned with a new soft switching converter topology with potential applications within power transmission and propulsion. The converter allows full four-quadrant operation and galvanic isolation by a transformer that can operate at arbitrary frequency.

All switching elements operate under zero-voltage or zero-current conditions and the overall switching losses will be kept at a low level. This allows for high switching frequency that reduces the levels of conducted EMI.

Furthermore, high frequency will also mean that the transformer will be smaller, less costly and more efficient. At high frequencies core losses in the transformer could become a problem.

However in this field a rapid technological development has resulted in new core materials with low losses at high frequencies such as amorphous steel, nano-christalline steel and iron powder.

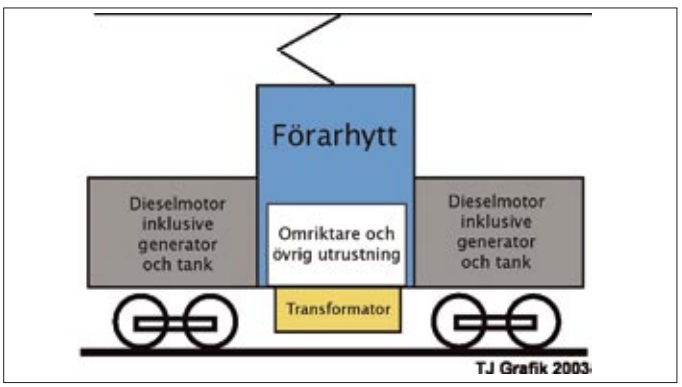
Kjellqvist T, Norrga S, Östlund S: *Design Considerations for a Medium Frequency Transformer in a Line Side Power Conversion System*. Proceedings of the 35th IEEE Power Electronics Specialists Conference, 21-24 June 2004, Aachen, Germany

Norrga S, Meier S, Östlund S: *A three-phase soft-switched isolated AC/DC converter without auxiliary circuit*. Conference Record of the 39th IEEE IAS Annual Meeting, Volume: 3 , 3-7 Oct. 2004 pp:1768 - 1775, Seattle, USA

**2. Dual system locomotives for freight transportation**

Research leader: Stefan Östlund

Within this joint project the Electrical machines and power electronics group is working with traction drives and the over-all performance of so called Dual system locomotives, that is locos powered both by Diesel engines and electricity from the catenary system.



# 2.7 Machine Elements (Dept of Machine Design)

**Personnel**

| | | |
|---|---|---|
| Research fellow | Ulf Olofsson Ph D | ulfo@damek.kth.se |
| Graduate student | Jon Sundh M Sc | sundh@damek.kth.se |
| Research engineer | Krister Sundvall M Sc | kristers@damek.kth.se |

**RESEARCH PROJECTS**

**1.Track-vehicle interaction (SAMBA6)–Tribology for the wheel rail contact**

| | |
|---|---|
| Project leader | Ulf Olofsson |
| Graduate student | Jon Sundh |
| Research engineer | Krister Sundvall |

Tribology, the science and technology of friction, wear and lubrication, is an interdisciplinary subject. It can therefore be addressed from several different viewpoints. This project focuses on the friction, wear and lubrication of the tiny contact zone (roughly 1 $cm^2$), where steel wheel meets steel rail, from a mechanical engineer's point of view.

In contrast to other well-investigated machinery, such as roller bearings, the wheel-rail contact is an open system. It is exposed to dirt and particles and natural lubrication, such as high humidity, rain and leaves, all of which can seriously affect the contact conditions and the forces transmitted through the contact. In contrast, in roller bearing the ball-cage contacts are sealed away. The steel rail meets a population of steel wheels from a number of different vehicles and the form of both the wheels and the rail can change due to wear. In contrast, a roller bearing meets the same rollers without any form change of the contacting bodies.

The profile change of rail on curves makes a large contribution to track maintenance cost. The profile change on wheels can also be significant, especially on a curved track. Damage mechanisms such as wear and plastic deformation are the main contributors to profile change.

Wear maps have been developed for different material combinations during unlubricated conditions. This work has been a joint project together with University of Sheffield and Otto-von-Guericke-Universität Magdeburg. Rail steel wear rates have reduced by up to an order of magnitude for the severe wear regime in the last 20 years due to better materials.

Further, gaps have been identified in current knowledge both in terms of rail steel wear data and wear mechanisms that provide a focus for new research in this area. Most of the material tests already performed have been done during contact conditions that correspond to the rail head - wheel contact.

For the contact conditions with the highest wear rate (wheel flange – rail gauge) there is very few published test results.

Leaf between railway wheel and rail can cause low friction in the wheel rail contact. This cause large maintenance cost and delays in traffic. A novel test method has been used to study how applied and natural lubrication (leaf and humidity) influence the coefficient of friction in the wheel-rail contact.

In 2003 Rickard Nilsson Department of Machine Design, defended his licentiate thesis Wheel/Rail wear and surface cracks.


Lewis R, Olofsson U: *Mapping rail wear transitions*, CM2003, Gothenburg, Sweden, June 10-13, 2003.

Telliskivi T, Olofsson U: *Wheel-Rail wear simulation*, CM2003, Gothenburg, Sweden, June 10-13, 2003.

Lewis R, R S Dwyer-Joyce R S, Olofsson U, Hallam R I: Wheel Material Wear Mechanisms and Transitions, 14th international wheelset congress, 17 – 21 October 2004, Orlando, USA.

Marshall M B, Lewis R, Dwyer-Joyce R S, Olofsson U, Björklund S: *Measuring Wheel/Rail Contact Stresses using Ultrasound*, 14th international wheelset congress, 17 – 21 October 2004, Orlando, USA.

Lewis R, Olofsson U: *Mapping rail wear regimes and transitions*, Wear vol. 257, (2004) 721-729.

Telliskivi T, Olofsson U: *Wheel rail wear simulation*, Wear vol. 257 (2004) 1145-1153.

Olofsson U, Sundvall K: *Influence of leaf, humidity, and applied lubrication on friction in the wheel-rail contact: pin-on-disc experiments*, Journal of rail and rapid transit, Volume: 218 (2004) 235 - 242.

Telliskivi T: *Simulation of wear in a rolling–sliding contact by a semi-Winkler model and the Archard's wear law*, Wear, Volume 256, Issues 7-8, (2004) 817-831.

Telliskivi T: *Half-space solutions for frictionless elastic normal indentation originating at a point contact,* TRITA-MMK Report 2003:10.


## 2.8 Vehicle Dynamics (Dept of Vehicle Engineering)

The group has a general interest in vehicle dynamics for ground vehicles. In railway research the focus is on the interaction between pantograph and the overhead catenary system.

**Personnel**

| | | |
|---|---|---|
| Professor | Annika Stensson Ph D | annika@kth.se |
| Assistant professor | Lars Drugge Ph D | larsd@kth.se |
| Researcher | Jenny Jerrelind Ph D | jennyj@kth.se |
| Graduate students | Pia Harèll Tech Lic | harell@kth.se |
| | Marten Reijm M Sc | marten.reijm@banverket.se |

#### RESEARCH PROJECT

**1. Overhead power systems for interoperability of high-speed trains**

Research leader Lars Drugge and Annika Stensson
Graduate students Pia Harèll, Marten Reijm
Source of funding Banverket

To enable high-speed train operation within Europe (interoperability), there are high demands on safe and uninterrupted traffic. Interoperability implies that the same pantograph will operate on both AC and DC lines, with different designs of overhead power systems.

Today, pantographs designed for these lines are characterised by vast differences in mass, stiffness and damping. To enable better performance, future pantographs will probably be equipped with active components to be able to control the contact force.

There will also be different demands on high-speed lines, upgraded lines and connecting lines. The mean contact force, standard deviation and amount of contact loss depend on several factors, such as the design of the overhead power system and pantograph, the train speed and the aerodynamic conditions.

As a consequence, it will be important to be able to evaluate and recommend actions to be taken in order to offer a secure and uninterrupted operation on a specific track. One of the demands on the certified lines for high speed is that they need to be compatible with the power systems of the trains.

To facilitate the handling of these complex problems, the aim of this project is to continue the development of the simulation tool that is used today at Banverket, so that it also includes the possibilities to evaluate these aspects connected to interoperability.

Also, this implies a need for enhanced knowledge and understanding of effects caused by different pantograph designs.

Harèll P, Drugge L, Reijm M: *Multiple pantograph operation – effects of section overlaps*, Vehicle System Dynamics, Suppl 41 (2004), 687-696.

Harèll P, Jerrelind J, Drugge L: *Experimental Measurements on a Pantograph*, Tolfte Nordiska Seminariet i Järnvägsteknik, June 1-2, Luleå, 2004

# 3. Graduate degrees

## 3.1 Ph D degrees

In 2003 Tanel Telliskivi, Department of Machine Design, defended his Ph D thesis *Wheel-Rail Interaction Analysis*.

In May 2003 Oskar Fröidh defended his Ph D thesis *Introduction of high speed trains. A study on the effects of the Svealand line on the travel market, travel behaviour and accessibility.*

In 2004 Jenny Jerrelind defended her Ph D. *Design and Control of Products Including Parts with Impacts*.

In May 2003 Gerard James of the Division of Structural Design and Bridges presented his Doctorate thesis *Analysis of Traffic Load Effects on Railway Bridges.*

## 3.2 Licentiate of Engineering degrees (Lic Eng)

In 2004 Pia Harèll presented her licentiate thesis *Pantograph-Catenary Interaction – Aspects on Pantograph Dynamics and Critical Catenary Sections.*

In 2003 Rickard Nilsson, Department of Machine Design, presented his licentiate thesis *Wheel/Rail wear and surface cracks*.

In June 2004 Roger Enblom presented his licentiate thesis *Simulation of wheela nd rail profile evolution-Wear medelling and validation.*

In June 2004 Nizar Chaar presented his licentiate thesis *Wheelset structural flexibility and vehicle-track dynamic interaction.*

In December 2004 Per-Anders Jönsson presented his licentiate thesis *Modelling and Laboratory Investigations on Freight Wagon Link Suspensions with respect to Vehicle-Track Dynamic Interaction.*

In 2004 Ulrika Johansson of the Division of Structural Design and Bridges presented her Licentiate thesis *Fatigue Tests and Analysis of Reinforced Concrete Bridge Deck Models*, TRITA-BKN. Bulletin 76, 2004.

In 2004 Esra Bayoglu Flener of the Division of Structural Design and Bridges presented her Licentiate thesis entitled *Soil-Structure Interaction for Integral Bridges and Culverts,* TRITA-BKN. Bulletin 74, 2004.

# 4. Undergraduate courses

In the undergraduate curriculum the different departments of the Railway Group KTH are responsible for 5 courses covering in total 25 credits, equal to 37.5 ECTS. The courses are described at the KTH web page: http://www.kth.se/student/studiehandbok/
One credit equals 1.5 ECTS credits.

#### RAILWAY TECHNOLOGY

- Railway Systems and Rail Vehicles: 6 credits (4B1304 /4B4304)
- Rail Vehicle Dynamics: 5 credits (4B1313/4B4317)

#### TRANSPORTATION AND LOGISTICS

- Rail Traffic Planning: 5 credits (1H1206)

#### ELECTRICAL MACHINES AND POWER ELECTRONICS

- Electric Traction: 4 credits (2C1149)

#### DEPT OF CIVIL AND ARCHITECTURAL ENGINEERING

- Rail Track Engineering: 5 credits (1C1206)

# 5. Postgraduate Course

**TRANSPORTATION AND LOGISTICS**

• Methods for Rail Traffic Planning: 5 credits (F1N5200)

# 6. External Courses

During year 2003 and 2004 the following external courses have been given:

1. Track-Vehicle Interaction: A course given for railway engineers as part of Nordisk Banteknisk Ingenjörsutbildning (NBIU), Tällberg, two days in September 2003. 30 participants. Evert Andersson.

2. Railway Systems and Rail Vehicles. A course given for railway engineers (and others) at Bombardier Transportation Sweden in Västerås, seven days in Sept-Nov 2003. 40 participants. Evert Andersson, Mats Berg, Karl Kottenhoff and Stefan Östlund.

3. Electric Railway traction. A one-day course as part of Nordisk Elteknisk Ingenjörsutbildning (NEIU) in Tampere Finland in November, 2003, 30 participants. Stefan Östlund

4. Rail vehicles and vehicle-track interaction. A course given for students of the programme Railway Engineer (LTH, Banskolan), Ängelholm and Stockholm, six days in September-October 2003. Six participants. Evert Andersson and Mats Berg.

5. Electric Railway traction. A one-day course as part of Nordisk Elteknisk Ingenjörsutbildning (NEIU) in Tampere Finland in November, 2004, 28 participants. Stefan Östlund

6. Track-vehicle interaction: A one-day course given for railway engineers at Banskolan, Ängelholm in February 2003. 11 participants. Evert Andersson.

7. Rail vehicles and their interaction with the track. A course given for railway engineers at Banverket, Norrköping, four days in April 2003. 14 participants. Evert Andersson and Mats Berg.

8. Track-vehicle interaction: A one-day course given for railway engineers at Banskolan, Ängelholm in March 2004. 9 participants. Evert Andersson.

9. Rail vehicles and vehicle-track interaction. A course given for railway engineers from Interfleet Technology, Stockholm Transport (SL), CSM Material Technology and A-Train. Six days in April-June 2004. 17 participants. Teachers from KTH: Evert Andersson, Mats Berg, Dan Brabie, Ulf Olofsson and Krister Sundvall.

10. Track-vehicle interaction. A course given for railway engineers as part of Nordisk Banteknisk Ingenjörsutbildning (NBIU), Tällberg, two days in September 2004. 30 participants. Evert Andersson.

11. Rail vehicle dynamics. A course given for railway engineers (in English), Indian Institute of Technology at Roorkee, six days in November 2004. 30 participants. Teacher from KTH: Mats Berg.

# 7. Publications, dissertations, theses and text books

## 7.1 Railway group publications

Annual report 2002, Publication 0301

## 7.2 Dissertations

Fröidh O: *Introduction of regional high speed trains. A study of the effects of Svealand line on the travel market, travel behaviour and accessibility*. TRITA-INFRA 03-041. Doctoral dissertation 2003.

Jerrelind J: *Design and Control of Products Including Parts with Impacts.* Doctoral Thesis, KTH, Stockholm, Sweden, TRITA-AVE 2004:07.

Telliskivi T: *Wheel-Rail Interaction Analysis*, Doctoral Thesis, KTH, Stockholm 2003.

James G: 2003, Division of Structural Design and Bridges. *Analysis of Traffic Load Effects on Railway Bridges,* TRITA-BKN. Bulletin 70, 2003.

## 7.3 Licentiate theses

Harèll P: *Pantograph-Catenary Interaction – Aspects on Pantograph Dynamics and Critical Catenary Sections*. Licentiate Thesis, KTH, Stockholm, TRITA-AVE 2004:23.

Nilsson R: *Wheel/Rail wear and surface cracks*, Licentiate Thesis, KTH, Stockholm 2003.

Heinz W: *Passenger service times on trains, Theory, measurements and models.* TRITA-INFRA03-62. Licentiate Thesis 2003

Enblom R: *Simulation of wheel and rail profile evolution – Wear modelling and validation*, Licentiate Thesis, TRITA AVE 2004:19, KTH Railway Technology, 2004.

Chaar N: *Wheelset structural flexibility and vehicle-track dynamic interaction,* Licentiate Thesis, TRITA AVE 2004:22, KTH Railway Technology, 2004.

Jönsson P-A: *Modelling and laboratory investigations on freight wagon link suspensions with respect to vehicle-track dynamic interaction*, Licentiate Thesis, TRITA AVE 2004:48, KTH Railway Technology, 2004.

Johansson U: 2004, Division of Structural Design and Bridges. *Fatigue Tests and Analysis of Reinforced Concrete Bridge Deck Models,* TRITA-BKN. Bulletin 76, 2004, ISSN 1103-4270.

Bayoglu Flener, E., 2004, Division of Structural Design and Bridges. *Soil-Structure Interaction for Integral Bridges and Culverts,* TRITA-BKN. Bulletin 74, 2004.

## 7.4 Undergraduate theses

Jansson T: *Kapacitetsanalys av alternativt trafikeringsupplägg och utbyggnad av Mälarbanan*. Examensarbete 03-059 2003.

Fridlund J: *Marknadsundersökning av nytt kombitrafiksystem mellan Mälardalen och Skåne*. Examensarbete 03-059 2003.

Sipilä H: *Kapacitetsanalys av tågtrafik I Stockholmsregionen – Fallstudie med beräkningsmetod*. Examensarbete 04-069, 2004

Wolfmeier J: *Simulering av framtida tågtrafikupplägg mellan Stockholm och Uppsala*. Examensarbete 04-068, 2004

Zanuy A C: *Production systems for combined Traffic. A comparative analysis between Sweden and Spain*. Master thesis 04-052, 2004

Åkerberg M: *Spänningskvalitet i tunnelbanenätet – en studie av spänningens kvalitet i Stockholms tunnelbanesystem*, EX-ETS/EME 0419

Albexon A: *Parametric Estimation of resonant currents in a medium frequency converter,* EX-ETS/EME 0422

Larsson S: *On the design of a bi-directional power valve for natural commutation*, EX-ETS/EME 0421

Hansson J: *Prediction of flexural vibrations in rail vehicle car bodies using piezoelectric elements and passive shunt circuit*, M.Sc. Thesis, TRITA AVE 2003:15, KTH Railway Technology, 2003.

Dirks B: *Vehicle dynamics simulation of wheel wear for Swedish high-speed train X2000*, M.Sc. Thesis, TRITA AVE 2003:16, KTH Railway Technology, 2003.

Thomas D: *Development and verification of a multibody dynamic simulation model for a freight wagon with Powell Duffryn TF25SA running gear*, Studienarbeit, TRITA AVE 2003:19, KTH Railway Technology, 2003.

Gustavsson D and Movell D: *Simulation of movements of trains for the purpose of exterior sizing (gauging*), M.Sc. Thesis, TRITA AVE 2004:27, KTH Railway Technology, 2004.

Jain A: *Development of MATLAB graphical user interfaces for various vehicle dynamics aspects, summer internship report,* KTH Railway Technology, 2003.

Singhai M: *Development of MATLAB graphical user interface for calculation of railway ride comfort indices, summer internship report,* KTH Railway Technology, 2004.

## 7.5 Text books

Fröidh, O: Svealandsbanan: Tågtrafik som bidrar till regional utveckling. I *Vid vägs ände? Järnvägarna, klimatet och Europas framtida järnvägspolitik*, s 61–71, 2003

Östlund, S: *Electric Railway Traction*, (in Swedish), 233 pages, Dept of Electrical Engineering, KTH 2003

Andersson E, Berg M: *Railway Systems and Rail Vehicles part 1 and 2*, (in Swedish Järnvägssystem och spårfordon del 1 och 2), 440+450 pages, KTH Railway Technology, Stockholm, 2003

*Tågtrafikplanering*, 331 pages, Kompendium, Railway Group at Transportation and Logistics, 2003

Sundquist H: *Byggande, drift och underhåll av järnvägsbanor,* 253 pages, KTH

Sahlin S, Sundquist H: *Banteknik*, 120 pages, KTH

Knothe K and Stichel S: *Schienenfahrzeugdynamik*, Springer, 350 pages, 2003.

# 8. Other activities

## 8.1 Seminars

On May 20th , 2003 a seminar was arranged on The deregulations of the railways – experiences, lessons learned and the future. Speakers were: Jonas Bjelfvenstam Ministry of Industry, Employment and Communication; Magnus Persson SJ AB; Jan Johansson General Manager Tågkompaniet AB, Jan Brandborn Ministry of Industry, Employment and Communication and Stefan Östlund KTH.

On June 10th 2004 a seminar was arranged on Rail traffic in the Stockholm region. Speakers were: Oskar Fröidh KTH; Per-Arne Kreitz Swedish National Rail Administration; Jonas Holmgren KTH; Thomas Ahlberg SL and Bo Lennart Nelldal KTH.

## 8.2 Awards

Ben Diedrichs was given two awards in 2003 for his IMechE paper On computational fluid dynamics modelling of crosswind effects for high-speed rolling stock: George Stephenson Prize as well as Agnew and Gordan Meritorious Award.

Sebastian Stichel received the title “Docent” (Associate Professor) in January 2004.

Shafiquzzaman Khan received the title “Docent” (Associate Professor) in February 2004.

## 8.3 Scientific assignments

Mats Berg was faculty opponent of Clas Andersson’s Ph.D. thesis, Modelling and simulation of train-track interaction including wear prediction, at Chalmers University of Technology, Gothenburg, June 2003.

B-L Nelldal was opponent of Sofia Ohnells licentiate thesis ”Intermodal Road-Rail Transportation for Express Transport Services” at Chalmers University of Technology in Gothenburg, Sweden 2004

Oskar Fröidh was opponent of Bosse Hansson’s licentiate thesis ”Infrastruktur och regionförändringar” (Infrastructure and regional changes) at School of Economics and Commercial law, Gothenburg University 2003

Sebastian Stichel was opponent of Anders Johansson’s Licentiate thesis, Out-of-round railway wheels – Literature survey, field tests and numerical simulations, Chalmers University of Technology, Gothenburg, September 2003.

Evert Andersson and Mats Berg have reviewed papers for the Journal of Rail and Rapid Transit.

Stefan Östlund has been acting as reviewer for IEE Proceedings B in the area of Electric Railway Traction.

Mats Berg has been acting as reviewer for the Journal of Vehicle Systems Dynamics.

Roger Enblom, Mats Berg and Evert Andersson have reviewed papers for the journal of Wear, related to 6th Int. Conf. on Contact Mechanics and Wear of Rail/Wheel Systems (CM2003).

Evert Andersson was member of the Editorial Board for Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit.

Evert Andersson was member of the Scientific Committe of the 6th Int. Conf. on Railway Bogies and Running Gears, Budapest, 13-16 September 2004.

Mats Berg is member of the scientific committee of Journal of Vehicle System Dynamics as well as the 19th IAVSD Symposium on Dynamics of Vehicles on Roads and on Tracks.

Mats Berg was member of the Organizing Committee for the 6th Int. Conf. on Contact Mechanics and Wear of Rail/Wheel Systems (CM2003).

**JÄRNVÄGSGRUPPEN KTH**
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