



HEAVY HAUL BEST PRACTICES & TECHNOLOGIES WORKSHOP

Narvik · Norway
June - 2019

DATE	SESSION	SLOT	TIME (min)	TOPIC	SPEAKER/PRESENTER
		0800 - 0830	30	Welcome from IHHA / Course Outline Course Leader Availability 4.0 – unlocking our assets' potential through technology Perpetuum Course Sponsor	Michael Roney Tony Ward
Day 1: Best Practices for Today's Freight Railways	1	0830 - 0915	45	Subgrade, Drainage, Transitions and Advanced Track Support Analytics	Dr. Hannes Gräbe
	2	0915 - 1000	45	Vehicle/Track Interaction and Ballast Maintenance	Rainer Wente
	3	1000 - 1045	45	Key Elements of Track and Bridges for Heavy Haul Operations	Dr. Nigel Peters
		1045 - 1115	30	Coffee Break	
	4	1115 - 1200	45	Wheel/Rail Interaction	Dr. Kevin Oldknow
	5	1200 - 1245	45	Best Practices for Maintaining Rail Integrity	Dr. Richard Stock
		1245 - 1330	45	Lunch	
	6	1330 - 1430	60	Wheel Maintenance Best Practices	Dr. Robert Frohling
	7	1430 - 1515	45	Wayside Detectors and Rolling Stock Management	Semih Kalay
		1515 - 1545	30	Coffee Break	
	8	1545 - 1630	45	Distributed Power, Optimal Long Trains and Control of In-Train Forces	Michael Roney
	9	1630 - 1715	45	Driver Assistance to Lower the Stress State and Maintain Schedule and Throughput	Thomas Nordmark
10	17:15 -18:00	45	Service Design and the Integrated Operating Plan	Mark Kirkpatrick	

Day 2 - Technologies for Railway 4.0	11	0800 - 0845	45	Health Monitoring of Switches & Crossings	Arne Nissen
	12	0845 - 0930	45	Five Years of Experiences Managing the Maintenance of the Iron Ore Line	Dr. Rikard Granström
	13	0930 - 1015	45	Experience of Health Monitoring of Trains	LKAB
		1015 - 1045	30	Coffee Break	
	14	1045 - 1130	45	Road to the World's First Large Scale Autonomous Freight Operations	Shaun Robertson
	15	1130 - 1215	45	A successful concept for testing of new Technologies – ePilot	Dr. Per-Olof Larsson Kråik
	16	1215 - 1300	45	Transformative Maintenance Solutions for Railway Assets	Dr.Uday Kumar
			60	Lunch	
	18	1400 – 1445	45	The Digital Revolution Transforming the Railroad	Robert Foy, GE Transportation
	19	1445 – 1515	45	Freight Wagons 4.0	Fredrick Kangas
	20	1515 - 1600	45	Communications Based Train Control	Teodor Gradinariu
21	1600 – 1645	45	Discussion and Lessons Learned	Michael Roney	

Introductory Session: Availability 4.0 – Unlocking our assets potential through technology – Justin Smithcombe

This will be a short discussion on how continuous remote monitoring of wheelsets and bogies has provided robust evidence of component performance in service that has been used to challenge maintenance regimes and mitigate operational disruptions. Perpetuum's paper for the IHHA 2019 conference highlights one such exciting area of development where vibration monitoring has been used to interrogate the data around the wheel rail interface, enabling operators and owners to monitor changes to rail and wheel condition in real time.

Justin Southcombe joined Perpetuum as Commercial Director in March 2014 after 18 years with Alstom.

Since joining Perpetuum, projects have been launched around the world, including new offerings on track, ride and traction motor monitoring, and Perpetuum has grown from 7 to over 60 employees.

Justin holds a BEng (Honours) in Mechanical Engineering from the University of Surrey, an MBA from INSEAD, has completed courses on Artificial Intelligence with MIT and is a Chartered Engineer with the Institute of Mechanical Engineers.

Session 1: Subgrade, Drainage, Transitions and Advanced Track Support Analytics – Hannes Grabe

This lecture concentrates on the function of the subballast layer and the subgrade as part of the entire track structure. Substructure terminology as well as the basic functions of each component will form the basis for the remainder of the presentation. The design of the track substructure layers will be discussed in terms of granular layer thickness design. Subgrade problems and remedial measures will be introduced as well as possible actions for axle load increases. Conventional and more advanced investigation methods and equipment such as Ground Penetrating Radar (GPR) and Continuous Surface Waves (CSW) will be discussed, followed by an introduction to inertial metrology and the use of digital sensors to measure and quantify track performance.

The second part of the lecture focuses on track drainage principles and specific examples of surface and subsurface drains. Geosynthetic products such as geotextiles, geomembranes, geogrids, geocells, geonets and geocomposites will be discussed with specific reference to the contribution that they can make with regard to separation, filtration, drainage and reinforcement. The lecture concludes with the important topic of track transitions and how differential stiffness and settlement are responsible for track component deterioration and vehicle dynamics at transitions. A range of possible solutions from ladder track to ballast reinforcement are proposed, highlighting the benefits of each in terms of differential settlement mitigation.

A brief outline of the lecture is as follows:

- Substructure components & functions
- Substructure investigations
- Substructure failure
- Drainage principles
- Drainage applications
- Track transition examples
- Design challenges
- Design solutions

Session 2: Vehicle/Track Interaction and Ballast Maintenance – Rainer Wenty

This lecture concentrates on the function of ballast and its influence on vehicle interaction, track quality, maintenance cycles, sustainability of maintenance and on track cost. The load bearing and load distribution function of the ballast will be explained, also the mechanisms which lead to ballast degradation. Examples of ballast degradation and its influence on track quality will be shown. Next step is how to determine the necessity of ballast rehabilitation. Different methods of ballast rehabilitation will be discussed and how to maintain a good track geometry. Hints will be given how to choose the right machine for certain demands and different track maintenance strategies will be discussed. Finally, life cycle considerations and best practice examples will be presented.

The lecture will cover, sequentially:

- The load transfer function of the track
- Drainage function of ballast
- Degradation of ballast
- Interaction of ballast quality and track quality
- Ballast cleaning/undercutting
- Track geometry
- Sustainability of track maintenance
- Digitalization aspects of track maintenance
- Optimization of track machine application

Session 3: Key Elements of Track and Bridges for Heavy Haul Operation – Nigel Peters

This presentation will cover matching key components contained within track and bridge structures to the axle load and tonnage demands of heavy haul railway lines. After a brief introduction of the load environment in which heavy haul track and bridges must operate, this presentation will break down the standards for track and structures that have been found to successfully sustain high integrity rail operations in heavy haul railway environments. The presentation will highlight the successful use of the following key components and their standards in line upgrading to match traffic increases and changes in heavy axle loads.

- Bridge components
- Rail selection and metallurgy
- Rail welding
- Ballast and sub ballast type
- Track fastenings
- Sleeper design
- Turnout design

Session 4: Wheel/Rail Interaction – Kevin Oldknow

Participants will be briefed on the fundamental science that governs the performance of wheel on rail as a system, and its damage mechanisms. The first part will answer the question: “What are the Stresses in the Wheel/Rail Interface and What Causes Them?” Normal contact (i.e. contact without rolling or slip) will first be explored, followed by tangential contact, in which tribological conditions and rolling friction become important. Fundamentals of creepage and creep forces will be explored, leading to explanations of steering and curving forces. Together with contact pressures, this will explain how rolling contact fatigue and wear develop on wheels and rails. Examples will be given of how these stresses are calculated and what they mean to yielding and plastic flow of rail and wheel surface layers.

The next part will address “How can we Estimate the Lateral Forces and L/V ratios vehicles are exerting on the Track?” This part will explain how vehicles steer and what impact this has on creepage forces and the damage that is caused. It will then relate how these estimates can be quantified and related to the extent of wear and fatigue and hence wheel and rail life. The presentation concludes with examples of how design and maintenance practices can improve wheel/rail performance.

Session 5: Best Practices for Maintaining Rail Integrity – Richard Stock

This lecture will focus on several important factors that have an impact on rail integrity and will show how these factors can be applied in practical railroad operations to maintain rail integrity and extend rail (as well as track) life.

The first factor is rail metallurgy. The most commonly used material concepts for rails will be discussed (pearlite, bainite) and how these material concepts are applied to extend rail life by mitigating the three most prevalent rail damage effects (plastic flow, wear and rolling contact fatigue). Typical examples of rail damage mechanisms and forms will be shown and how an optimized rail grade selection approach can help to mitigate these forms of rail damage.

Rail rectification by grinding or milling is another important factor for maintaining rail integrity. This part of the lecture will first look at different rail maintenance strategies and how these strategies can be used to keep control of rail degradation mechanisms as explained on the first part. The best practice strategy of preventive rail maintenance will be discussed in detail with focus on the possible application scenarios for such a strategy. In order to implement these rail maintenance strategies typically rail grinding or rail milling can be used. Both technologies will be analysed in detail by highlighting their strengths and limitation and by looking at specific application examples based on the before explained maintenance strategies. Furthermore, the importance of the longitudinal and transversal rail profile with respect to stress conditions, damage development and contact conformity will be discussed.

As a third factor the concept of friction management will be introduced. The friction between wheel and rail has a major impact on derailment safety, damage development and system energy consumption. The difference between lubricants and friction modifiers as well as the different material concepts for these material classes will be explained. The presentation will outline best practice friction levels dependent on the location on the rail (gauge face, top of rail) that will best balance wheel/rail forces, wear, locomotive traction and train braking. It will then turn to the characteristics that need to be considered in selecting a cost-effective friction management solution by choosing the right application methodology (on board vs wayside), selection of the most effective material and the appropriate number or spacing of the selected application systems. Furthermore, also railway system specific maintenance conditions need to be considered when choosing the most appropriate friction management solution.

Finally, all discussed factors will be combined on a rail/wheel system level. The individual optimization of these factors without considering the impact on the whole system might result in a drastically reduced system life. Only by considering the interaction of rail grade selection, friction management and an optimized maintenance strategy it will be possible to extend the life of the most valuable asset rail significantly, to maintain rail integrity and at the same time reduce the costs for the maintenance of the wheel/rail system.

Topics covered in the presentation:

- Rail grade selection and rail metallurgy
- Rail damage mechanisms
- The importance of rail maintenance
- Rail maintenance strategies
- Rail maintenance technologies: grinding and milling
- Practical application of maintenance strategies
- Friction Management – why control friction between wheel and rail
- Gauge Face Lubrication
- Top of Rail Friction Control

Session 6: Wheel Maintenance Best Practices – Robert Frohling

Wheel replacements are a major element of a rolling stock department's budget. Wheel performance in service, as affected by wheel profiles, wheel impacts, braking and rolling contact fatigue also affects rolling stock and track.

This presentation will start by identifying the mechanisms of wear and fatigue of wheelsets and will then discuss allowable limits that affect wheel performance. It will then cover the aspects of wheel profile design and how design profiles are maintained. Wheel measurement systems will be outlined along with practical best practice examples of how wheel data can be collected and processed to make good decisions on timing of re-truing, replacement, and forecasting of demand on mechanical shop resources.

Finally, the presenter will discuss how wheel truing and replacements cycles can be integrated with the requirements for bearing inspection and replacement, comparing the benefits of time-based vs. condition based maintenance.

Session 7: Wayside Detectors and Rolling Stock Management – Semih Kalay

The heavy haul railways around the world are increasingly moving toward detector and performance-based rolling stock maintenance to improve efficiency by reducing the cost of maintenance and inspection. Advances in sensors, data collection systems, computer software and communications have enabled the development and deployment of sophisticated, reliable and accurate wagon health monitoring systems capable of automating many train inspection processes; offering opportunities to replace, supplement and enhance the safety and productivity of railway operations. In many instances automated wagon health monitoring systems are capable of examining vehicle performance attributes while in motion, providing additional insight on vehicle behaviour in a dynamic on-track environment.

Currently, the various car health monitoring systems are being used to identify poorly performing cars and bogie components. In the near future, technology will allow for the detector systems to be integrated in order to assess the overall condition of the car and its components and to plan shorter and longer term and proactive maintenance actions. Automated wayside and onboard wagon condition monitoring devices are expected to free wagon inspectors to concentrate on freight wagon repairs to improve productivity of rail operations. As a result, inspection cycles for rolling stock will be extended, and maintenance will be performed when needed.

The detector data management systems store the detector data and provide users with the capability to make predictive, condition-based maintenance decisions rather than having to rely solely on visual inspection. It also makes data available to a wider range of stakeholders than possible before. This means that wagon owners, who did not previously have access to inspection data, can (given railroad permission and a password to access the data) manage their assets remotely. These databases use a variety of automated equipment identification systems located at detector sites to determine vehicle location, direction of operation, and load condition. This information is then utilized to determine optimal maintenance locations.

This presentation will answer the following questions:

- How is the data from vehicle health monitoring systems used to manage rolling stock maintenance? Various real-world examples of how the railroads are using detector data to manage the inspection and maintenance of their rolling stock.
- How do I identify out-of-round wheels and wheel surface defects using wayside detector systems?
- How can I identify overload and imbalanced loading in wagons?
- What type of technology is available to detect poorly performing wagon bogies?
- How can I use wayside temperature detectors to determine brake effectiveness?
- How do automated wheel profile and brake pad measurement systems work?
- How can I identify defective axle bearings defects long before they cause overheating?
- Are there any technologies available to inspect wheel internal and surface defects?
- What are the latest developments in machine vision systems to determine a railcar's safety?

Session 8: Distributed Power, Optimal Long Trains and Control of In-Train Forces – Michael Roney

This presentation will start with a comparison of train lengths that are used on the heavy haul railways around the world. Participants will be briefed on the benefits and operational challenges of longer trains, differentiating between single and double track situations, and in dedicated and mixed freight environments. The lecture will then illustrate the impact of train length on longitudinal forces, dynamic transients in the train and lateral curving forces, and how these are influenced by the positioning of distributed locomotive power, and driver assist systems.

The third part of the presentation will outline marshalling rules used in making up longer trains that make them more productive and less destructive. Finally, the presenter will review how communications-based train control and autonomous driverless trains may reshape the optimisation function on train length, as tighter headways become possible as alternate means of raising capacity.

Session 9: Driver Assistance to Lower the Stress State and Maintain Schedule and Throughput – Thomas Nordmark

This presentation will trace the evolution of technologies that provide driver-assistance. It will cover the functioning of sensors and systems that can assist train drivers to:

- Maintain trains to the schedule
- Conserve energy consumption
- Reduce in-train forces
- Anticipate and pace trains to meet or service disruptions
- Reduce the risk of broken rails from wheel impacts

The presenter will discuss how each of the above driver assistance systems improves safety and service reliability and how they may play a role in autonomous train operations.

Session 10: Service Design and the Integrated Operating Plan – Mark Kirkpatrick

This presentation will lay the context for how train operations can be scheduled and run with precision, using the central driver of the integrated operating plan. The presenter will address the following questions on an experiential, rather than an academic basis:

- What are the key features of Service Design in developing an integrated operating plan?
- What options does a service design team have to improve the logistics of a working operation?
- What are the typical costs for consideration for a service design team?
- What are key metrics for measuring the success of an integrated operating plan ?

The lecture will conclude with a couple of case studies from actual railways that will illustrate their applications, and the metrics that drive their operating plans.

Session 11: Health Monitoring of Switches and Crossings – Arne Nissen

Switches and crossings are both higher maintenance components of railway track, and are also locations of higher risk, and potential service disruptions. This presentation will discuss how switches have traditionally been inspected, noting the key inspection points of their wear and subsequent performance.

In recent times, new technologies have become available that can provide real time monitoring of power switches. Sensors can measure and report on their throw force and information related to the time required to complete a cycle. This information reveals potential issues with the operation of a switch. When the measured current draw starts to move outside of the prescribed envelope, this would prompt an inspection, and possible adjustment of the switch mechanism, throws or switch point support weekly.

The presentation will discuss how technologies can supplement manual inspections of switches, including the use of machine vision systems.

Session 12: Five Years of Experience Managing the Maintenance of the Iron Ore Line - Rikard Granstrom

The presentation sets out to give the auditorium a unique insight into the every-day workings of a project manager for infrastructure maintenance of the Swedish Iron Ore line. The Iron Ore line has been operational since 1902 and has since then gone through several upgrades, e.g. electrification, signalling, increased axle loads (since 2017 32.5 tonnes axle-load), new stations, and extended stations to accommodate longer trains.

Since the physical character of the Iron ore line has evolved over such a long period of time, interesting and perhaps unique features and challenges follow for the maintenance of the asset. One of the features is the multitude of factors affecting the degradation of the asset. Parts of the railway are built on almost solid bedrock, while other parts are built on wetlands with spruce beds and peat. On top of this, the line is as patchwork of new and old technologies, an age that range from newly installed items to items close to their end of life (and even items that have surpassed intended life length and require preventive maintenance), and items with a condition on the degradation curve ranging from as-good-as-new to faulty.

All this amounts to sections of the railway with inherent and perhaps unique degradation models. The difficulty for the project manager is to find the appropriate maintenance tasks with regard to the multitude of degradation parameters or sometimes new degradation effects that appear after e.g. increased axle loads. Much of the problem is related to the coordination and packaging of maintenance tasks. For example, is it appropriate to change a component (e.g. tongue) in a switch, or is the appropriate task to change the tongue, sleepers, ballast and make efforts to assure that the drainage is working properly?

The presentation is based on real examples from the last five years of managing the maintenance of the southern part of the Iron ore line. Real examples are used to discuss degradation behaviour, maintenance planning, maintenance production and decision support (which can be rendered from either condition monitoring technologies or statistical methodologies).

Session 13: Experience of Health Monitoring of Trains –LKAB

This lecture will present a holistic view of giving a trainset a clean bill of health through the combined use of manual inspections and both onboard and wayside monitors. The session will provide a practical account on how health monitoring systems integrate with the planned maintenance and availability of trainsets to reach tonnage throughput requirements. This leads to decisions on the optimal timing to schedule programmed maintenance for trainsets and the benefits of taking full trainsets out of service for planned work vs. condition-based wagon maintenance. Examples of maintenance “rules engines” will be presented. Key inspection points and reliability-centred maintenance of this componentry will be covered as best practice guidance.

Session 14: Road to the World's Large Scale Autonomous Freight Operations Train Operations – Shaun Robertson

This presentation will take participants through the pioneering steps that were followed at Rio Tinto in the Australian Pilbara to successfully commence AutoHaul©. Participants will learn how conventional diesel electric locomotives were retrofitted to support autonomous train operations that have involved full integration with communications-based train control and use of LIDAR technology to detect potential hazards. The presentation will trace the benchmarks which led to decisions to launch automated trains, first with drivers overseeing the train operation and then fully autonomous train starts. Participants will be briefed on the important role of advanced communications capabilities to support autonomous trains and the range of new skillsets that have been required of employees.

Finally, the presentation will discuss benefits of autonomous trains for Rio Tinto, including impacts on train cycle times and their variances.

Session 15: A Successful Concept for Testing of New Technologies – ePilot - Per-Olaf Larsson Kraik

New technologies are emerging. The Industry 4.0 concept is transforming heavy haul maintenance and operations. This will influence and change how we do things. Increased digitalization has led to greater information transparency, and the railway industry has taken a more holistic approach when it comes to collaborative information logistics. Hence, there is a need to identify why good 4.0 ideas stop at good ideas and not evolve into good praxis in the railway industry.

In Sweden, the collaboration platform *ePilot*, has shown that it is possible to evolve 4.0 concepts and aid successful transfer of new technologies in the railway business. The collaboration platform involves different stakeholders, i.e. research and development (Academia), Infrastructure Managers, Railway Operators, Maintenance Contractors, Suppliers and Consultants.

ePilot aims to get all above stakeholders to jointly improve maintenance of the railway system through enabling context-based condition-based maintenance.

Trafikverket initiated ePilot in 2013 and the ePilot provides a collaboration platform for the development of solutions for maintenance decision support based on the needs and requirements from various stakeholders. This presentation will describe the factors for enabling a successful collaboration, collaborative methodology, and implemented results from the ePilot project.

Session 16: Transformative Maintenance Solutions for Railway Assets - Uday Kumar

In the past, many railway assets were overdesigned and underutilized making the need for effective and optimized maintenance planning non-existent. With passing years, many of these assets (infrastructure and rolling stocks) are getting old and at the same time their utilization has increased. The major challenge is to find the time slot to perform maintenance on the infrastructure and rolling stocks to maintain its functionality and ensure safe train operation. These challenges have led to the search for innovative maintenance solutions and deployment of new and emerging technologies to facilitate the use of predictive maintenance strategy as and when it is economically and technologically viable. So far, railways have been dealing with standard technologies and tools required to run the railway in an effective and efficient way. These technologies can be broadly classified as supporting and optimizing technologies and collectively provide the foundation for the predictive technologies that are used for the estimation of the remaining useful life (RUL) using condition monitoring tools and technologies, RAMS (reliability, and maintainability and safety) modelling, LCC analysis, etc. to arrive at the correct maintenance decision.

The on-going digitalization of railway asset condition (infrastructure and rolling stocks) provides enormous capabilities for the sector to collect vast amount of data and information (i.e. Industrial Big Data), from the railway assets in operation. Gradually, the railway sector is adapting and adopting operation and maintenance practices aligned to big data scenarios

Railway systems have complex technologies, with a wide range of standard maintenance solutions and organization forms. During the last few years, the focus has been to find transformative maintenance technology and business solutions for these assets which will ensure safe and failure free train operations at the lowest possible maintenance cost. Such solutions should make mature railway assets highly utilized with almost no risks. To This real time data driven approach railway operations is expected to transform the way railway assets are operated and maintained, ensuring increased reliability and quality of service, increased capacity and reduced life cycle costs for the asset. To get useful information out of high volumes of data generated by railway assets, advanced tools are developed and implemented so that data can be systematically processed into information and facilitate decision making with more information.

These technologies, such as Virtual Reality (VR) , Augmented Reality(AR) , Big data analytics (predictive and prescriptive analytics), industrial Internet of Things(IIoT) , 5G communication technologies that offer near perfect solutions (even in real time) for the maintenance of the aging railway assets, are collectively termed as transformative technologies. Such transformative technologies are expected to facilitate correct decisions and actions at the lowest possible cost using the power of predictive and prescriptive analytics by the railway managers. Such solutions are expected to support railway's digital transformation journey and operations goals. The presentation will be centered on the capability of enabling technologies that will facilitate development of transformative technologies for the effective maintenance of railway assets using the power of predictive and prescriptive analytics.

Session 18: The Digital Revolution that is Transforming the Railroad –Robert Foy

This session will focus on both new and recent technology developments planned to support more efficient train operations and also train automation to combat the threat posed by autonomous trucks. In particular, we will discuss:

1. Locomotive technology to comply with Tier 4 emissions requirements
2. Recent trends to modernize older DC locomotives with AC traction and to quantify those benefits
3. Advances in Energy Management systems (EMS)
 - a. Measured fuel conservation performance
 - b. Automatic control of distributed power remote locomotives to manage in-train forces
 - c. New consist control features such as "Smart Horse Power per Ton"
 - d. EMS as an emission credits generator
4. Next generation distributed power capabilities
5. Battery electric freight locomotives and their potential benefits
6. Our vision of the likely progression of automated freight trains in open rail networks
 - a. Sensor systems required
 - b. Automatic Train Protection (ATP) interface
 - c. Proposed industry standards for road locomotive remote control
 - d. Initiatives to automate the work load of train crews
 - e. Vision for remote monitoring & diagnostics of automated trains
 - f. Benefits of train automation beyond labor productivity

Prof. Hannes Gräbe

South Africa

University of Pretoria – Department of Civil Engineering

BEng (Civil Engineering)

MEng (Geotechnical Engineering) PhD

(Geotechnical Engineering)



Hannes Gräbe is a civil engineer, passionate about railways, with experience in the fields of Track Technology, Geotechnology, Advanced laboratory testing, Field investigations, Maintenance models and Numerical analysis of track structures.

He is currently employed by the University of Pretoria as Associate professor: Transnet Freight Rail (TFR) Chair in Railway Engineering and the Railway Safety Regulator (RSR) Chair in Railway Safety where he lectures under- and post- graduate courses in Railway Engineering. He is responsible for railway research as well as continued professional education in the form of short courses presented to industry.

Prof. Gräbe is author and co-author of several journal and conference papers and frequently presents his research at international conferences in South Africa and abroad. He serves on the TFR School of Rail Advisory Board, the Transportation Research Board (TRB) committee on Rail Maintenance in the USA and the RAILENIUM Strategic & Scientific Council based in France.

Prof. Gräbe is fellow of the South African Institution of Civil Engineering (SAICE) and registered with the Engineering Council of South Africa (ECSA) as a professional Engineer.

Ing. Rainer Wenty

Austria

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Date of birth: May 2nd 1946 in Luebeck, Germany

Citizenship: Austria

Rainer Wenty, a mechanical engineer, is Manager of Strategic Marketing for Plasser & Theurer in the company's Vienna, Austria main office. He has been with the company since 1967 and has wide spread international experience in track technology and the application of track maintenance and -construction machines - both, technically and economically. Mr. Wenty has also authored numerous technical papers for trade publications and conferences.

He is co-author of the heavy haul best practice book and has participated as presenter in the past track maintenance Heavy Haul workshops.

Rainer Wenty is also co-founder and member of the joint track substructure expert group of Austria, Germany and Switzerland.

Further memberships are OVG (Austrian Society of Traffic Science) - Chairmen of the Vienna Branch of OVG, VDEI (Association of German Railway Engineers), AREMA (USA)

Dr. Nigel Peters

Canada

Railway Consultant

B.Sc. (Civil Engineering - structural)

M.Sc. (Civil Engineering _ structural)

Ph.D. (Civil Engineering – Structural)



Dr. Peters is a civil engineer with 40 years of railway experience. He started his railway career with Canadian National Railways (CN) in 1978 as a summer student, surveying. He spent many years as CN's Track Standards Engineer and later as the Chief Engineer of Bridges and Structures and Track Standards.

Throughout the years Dr. Peters has been involved with such topics as track standards, special trackwork, track train dynamics, rail manufacture, rail metallurgy, fracture mechanics, contact stress mechanics, CWR, rail welding, and numerous topics associated with railway bridges. Dr. Peters also spent 4 year as Technical Director for Voest Alpine Nortrak. He has authored several papers and has guest lectured at several universities.

Dr. Peters retired from CN in 2014 and currently has his own international railway consulting company.

Dr. Peters is a past Vice President of the American Railway Engineering and Maintenance of Way Association (AREMA) and an active member of AREMA Committee 4 (Rail) and Member Emeritus of Committee 5 (Track). He is also a Fellow of the American Society of Civil Engineering (ASCE) and a registered professional engineer in the province of British Columbia, Canada.

Dr. Kevin Oldknow

Canada

Simon Fraser University



Dr. Kevin Oldknow, P.Eng., is Associate Dean in the Faculty of Applied Sciences at Simon Fraser University, and inaugural Director of SFU's Sustainable Energy Engineering program. As Senior Lecturer in the School of Mechatronic Systems Engineering, Oldknow has taught courses in dynamic systems modeling and simulation, industrial control systems, manufacturing systems, technology and society, engineering economics and technology entrepreneurship.

Kevin also has 20 years of industrial experience, primarily in railway systems. This has included an array of domestic and international projects on passenger and freight rail systems, including vehicle-track studies and simulation work, and the deployment and verification of technologies for asset life extension and improved system performance. He has held technical, strategic and senior management roles at Procter & Gamble, Cameleon Controls, Kelsan Technologies, Portec Rail Products and LB Foster Rail Technologies.

Oldknow holds a B.A.Sc. in Engineering Physics from the University of British Columbia, and an M.A.Sc. and Ph.D. in Mechanical Engineering (also from UBC). He has published in the areas of dynamics and controls, wheel-rail and vehicle-track interaction, tribology and friction control, and engineering education.

Dr. Richard Stock

Canada

Richard Stock was born in Leoben/Austria. He is holding a masters and Phd degree in material sciences from the University of Leoben / Austria.

Richard worked for 12 years at voestalpine in Austria in the R&D department and in technical customer service. He was responsible for wear and RCF issues of rails and he was project manager for a number of national and international university collaborations. He also participated in the European Union project Innotrack dealing there with simulation of wheel rail contact, the influence of rail grade on wear and RCF and rail maintenance.



Between March 2010 and November 2010 Richard was seconded to KELSAN Technologies (now LB Foster Rail Technologies) in Vancouver based on the research collaboration between LB Foster and voestalpine Schienen GmbH.

In September 2013 Richard joined LB Foster Rail Technologies in Burnaby / Canada in the position of Rail Technology Manager. In this position he was responsible for various R&D processes and projects, for managing university collaborations and for high level technical customer interaction. Besides this R&D function Richard was also leading the Application Engineering group that provides support for conducting and analysing field trials.

Since April 2017 Richard is working for LINMAG Rail Milling Services and LINSINGER Austria as Milling Technology Manager based out of Vancouver/Canada. In this function, he is responsible for promoting LINSINGER milling technology in North America and to provide support with respect to rail-wheel contact related problems. Besides, Richard is also representing both companies globally at standards committees, conferences, workshops and trade shows.

Richard is also member of AREMA Committee 4, APTA Track and Noise/ Vibration Technical Forum and OVG (Austrian Society of Traffic Science).

Dr. Robert Fröhling

South Africa

Principal Engineer , Mechanical Technology, Transnet Freight Rail

BEng (Mechanical)

BEng (Hon) (Structural Dynamics)

MEng (Mechanical)

PhD (Railway Engineering)



Dr. Robert Fröhling has 37 years of railway experience in vehicle system dynamics, vehicle/track interaction, wheel/rail interaction, bogie technology, structural mechanics as well as locomotive and wagon mechanical design integrity. To date he has published and/or presented over 60 international papers on these core railway technologies.

Robert is currently amongst others a member of:

- The Editorial Board of the “Vehicle System Dynamics International Journal of Vehicle Mechanics and Mobility”.
- The Editorial Board of the “Journal of Rail and Rapid Transit, Part F of the Proceedings of the Institute of Mechanical Engineers”.
- The Advisory Board of the Department of Mechanical and Aeronautical Engineering of the Faculty of Engineering, Built Environment and Information Technology at the University of Pretoria.

Robert is a fellow of the South African Academy of Engineering (SAAE) and registered with the Engineering Council of South Africa (ECSA) as a Professional Engineer.

Semih Kalay

U.S.A.

Railway Research and Technology



Mr. Semih Kalay worked for the Transportation Technology Center, Inc. (TTCI), in Pueblo, Colorado, and for the AAR, Association of American Railroads, in Chicago, Illinois for 36 years,

before retiring as Senior Vice President, Technology.

Mr. Kalay's responsibilities at TPCI included overall management of the North American Strategic Research program, and technical support and oversight on AAR Technical Standards and inspection, and as one of TPCI's Corporate Officers responsible for the management of the company. Mr. Kalay served as the member of the World Congress in Railway Research (WCRR) Executive and Organizing Committees, as well as on the International Heavy Haul Association (IHHA) Board, representing USA. He served as Chairman of both organizations various times. Mr. Kalay also served on the Transportation Research Board, the International Wheelset Congress' Technical Committee, chaired European Railway (UIC) committees, and other Engineering and Railway Associations in the USA.

Mr. Kalay has authored more than 250 professional articles, technical reports, delivered several hundred speeches at professional forums nation-wide and internationally. He holds several US patents and his technical papers have earned many international awards. Mr. Kalay holds a BS and MS Degrees in Mechanical Engineering.

He lives in Colorado Springs, Colorado with his wife Grace.

Michael Roney, Int PE

Canada

Michael Roney is an internationally registered professional engineer and consultant in railway engineering and management through his company, Iron Moustache, and has recently completed projects in Australia, China, India, South Africa, Scandinavia and USA. He retired in 2013 as General Manager, Track and Structures and Chief Engineer with Canadian Pacific Railway, where he was responsible for track and structures standards, rail maintenance, bridge design, geotechnical groups and track inspection processes. He had a 32 year career with Canadian Pacific, in engineering, materials and systems management and maintenance-of-way, including positions as General Manager Track Maintenance, and Director Engineering Standards and Systems.. He has also worked with the National Research Council of Canada as General Manager of their Rail Division, with BHP's Melbourne Research Labs and with Queen's University at Kingston, Ontario, where he holds a Master's degree in Civil Engineering. He is past Chairman of the International Heavy Haul Association and past Chairman of consultant CPCS Transcom Limited. Mr. Roney is a past president of the American Railway Engineering and Maintenance-of-Way Association and is on the Institution of Mechanical Engineers Editorial Board for the Journal of Rail and Rail Rapid Transit.



Dr. Rikard Granström

Sweden

Present employment

- Trafikverket (Swedish transport administration), project manager infrastructure maintenance for the southern part of the iron-ore line. Work also involves facilitation and participation in research and development (R&D) projects related to decision support generation, condition monitoring and field tests, Luleå 2013-. Two examples of ongoing R&D projects are: Reality Lab Digital Railway, where I am project member with responsibility for field tests; Gus (Overall Maintenance Support), where I participate in the development and execution of a maintenance course for employees at Trafikverket.



Some previous periods of employments

- Vectura Consulting AB, analyst and project management, Luleå, 2008-2013
- Luleå University of Technology (LTU), Division of operation & maintenance engineering, PhD candidate, Luleå 2003-2008
- Banverket Projektering, railway signalling engineering, development of train traffic control systems and condition monitoring, Luleå 2002-2008
- Bombardier Rail Control Solutions (RCS), Signalling engineer, software developer, on-board signalling, 2001-2002
- 1997-1998 Enator Miltest, Telecommunications technician

Academic degrees

- Doctor of Philosophy (PhD), operation & maintenance engineering, LTU 2008
- Licentiate in Engineering, operation & maintenance engineering, LTU 2005
- Bachelor of Science (BSc), electronics engineering, LTU 2001

Research profile

My research profile is primarily related to the application of information and communication technologies (ICT) to support decision making regarding maintenance of railway infrastructure assets. Work is carried out by analytical methods to establish causal relationships between functions, failures and related effects and consequences, documented in maintenance programs and supported by ICT solutions for inspection and fault management.

There are a lot of documentation (rules and regulations) stipulating what kind of maintenance, and what amount of maintenance, that should be carried out on the Swedish railway infrastructure assets. However, there is almost no documentation describing why specific maintenance tasks should be carried out and why

they are to be carried out at certain intervals or at certain levels of degradation. This becomes a challenge when an administration like Trafikverket sets out to make modifications of present rules and regulations or when setting out to implement condition monitoring (CM) solutions to support changes of existing maintenance programs. The net result is often that regulations remain unchanged, or more or stricter regulations are added or that promising CM technologies are not implemented in regular maintenance programs.

Key questions;

- How can Trafikverket (the Swedish transport administration) validate that proposed changes to maintenance programs for the state owned railway infrastructure are appropriate?
- How can Trafikverket validate that proposed CM technologies are appropriate for asset management of the railway infrastructure?

In order to come to terms with the situation, present maintenance programs have to be reversed engineered, as well as proposed changes and proposed CM solutions have to be validated. Within my research the methodology Failure, Mode, Effects & Criticality Analysis (FMECA) has been applied in order to analytically and systematically document the rationale for present maintenance programs and evaluate the impact of possible improvements and new technologies. The application of FMECA in combination with Design of Experiments (DoE) and statistical methods shows promising results for implementing changes in maintenance programs and for implementing CM technologies. Case studies has been carried out within maintenance of switch heating, maintenance of level-crossings and maintenance of the interface between pantograph and overhead wire.

Shaun Robertson

Australia

Principal Advisor – Rail
Productivity & Technical Support

Rio Tinto
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Dr. Per-Olaf Larsson-Kråik

Sweden

Trafikverket

PhD Per-Olof Larsson-Kråik works as a senior adviser at Trafikverket (Swedish Transport Administration) with R&D for Technical systems in Operation and Maintenance of Railways. He is also adjunct Professor and faculty member of Luleå University of Technology in Sweden.

He is Director and Coordinator of Nordic Heavy Haul Association, a Scandinavian non-



governmental, scientific and technological association of heavy haul railways. As Research Coordinator, he has been involved in the preparation and execution of several projects in EU Framework research programs FP6, FP7 and H2020.

He has written over 90 articles and cases studies in the areas of Maintenance, Tribology, Reliability, Maintainability, Logistics, and Supportability. He has supervised several Masters and Ph.D. students at Luleå University of Technology, Uppsala University, Queensland University of Technology, and Central Queensland University. He has supervised more than 10 PhD students.

Prof. Uday Kumar

Sweden

Luleå University of Technology

Prof. Kumar is the Chair Professor of Operation and Maintenance Engineering and Director of *Research and Innovation* (Sustainable Transport) at of Luleå University of Technology and Director of Luleå Railway Research Center.



He has more than 30 years of experiences in consulting and finding solutions to industrial problems directly or indirectly related to reliability and maintenance of engineering systems. He has published more than 350 papers in International Journals and Conference Proceedings, and has co-authored 4 books on Maintenance Engineering, has edited several volume of maintenance literature and contributed to World Encyclopaedia on Risk Management. He is one of the Series Editors of literature on Asset Analytics – Performance and Safety Management published by Springer Nature Ltd.

Prof. Kumar is one of the Editors -in -Chief for International Journal of System Assurance and Management and Area Editor (Europe) for Journal of Quality in Maintenance Engineering (JQME).

He is an elected member of the Royal Swedish Academy of Engineering Sciences. He was awarded the coveted Nordea Science Foundation Award for significant contribution to society and region (2014), Life Time Achievement Award from Society of Reliability and Safety (2015), APCOM council Recognition Award (2015), recipient of Distinguished Alumnus award of IIT BHU for the year 2017, etc.

Prof. Kumar is also a Visiting Guest Professor at National Science Foundation sponsored Center of Excellence for Intelligent Maintenance Systems at University of Cincinnati, Ohio, USA, Distinguished Professor of Industrial Engineering at Tsinghua University, Beijing, an Honorary Professor at Beijing Jiao Tong University, China, an Honorary Professor at Amity International Business School University, Amity University, etc. Earlier, he has been a visiting faculty at Imperial College London, Helsinki University of Technology, Helsinki, Stavanger University in Norway, Tromsø University, Norway and external Examiner & Program Reviewer for the Graduate Program in the area of Asset and Reliability Engineering at University of Manchester, UK, etc

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France

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WORK EXPERIENCE

2000 – today

Union Internationale des Chemins de Fer (UIC) – 16 rue Jean Rey ,7. Paris-France (<http://www.uic.org>)

Senior Technical Advisor- Technical Coordinator
Railways domain.

Expertise on: signalling, operation (traffic management), asset management, technical-economic studies, strategy and development, Satellite navigation applications, European research programs (former ERAC Secretary – 2015).

1999-2000

CFR SA (Romanian National Railways Company), Bd. Dinicu Golescu Bucuresti, Romania (www.cfr.ro)

Deputy Director General – in charge for strategy & development, technical investments and EU and International funds.

1998-1999

CFR SA (Romanian National Railways Company), Brasov Region Directorate, Str. Politehnicii nr.1, Brasov, Romania.

Director General: managing railways region

1996-1998

Technical Director: responsible development, investments, technical

1992-1996

Safety Manager: responsible for safety management system on the railways

1990-1992

Technical Manager – implementation and management of technical

1981-1990

Engineer – different positions in the main activities of the railways region, and middle manager for operation and signalling.

EDUCATION AND TRAINING

1999

Management Training Programme – Utica College of Syracuse University, USA

1976-1981

University “Politehnica” of Bucharest – Faculty of Transports – Master in Railways Transportation.