

Systems leadership

# METRE-GAUGE VEHICLE – TRACK INTERACTION

#### This information letter contains:

- > Objectives and tasks of the systems leadership
- > The six projects in brief
- > Who is RAILplus



Editorial by Joachim Greuter

## VEHICLE-TRACK INTERACTION. A COMPLEX SYSTEM.

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#### Ladies and Gentlemen,

The interaction between the vehicle and the track is complex and requires a balanced overall design. In recent years, many metre-gauge railways have experienced problems directly related to this interaction. A collaborative project is now underway to tackle and solve these problems.

Excessive wear on the wheel and rail due to these problems is primarily a financial challenge. It requires interventions to be carried out more frequently on the infrastructure (grinding, lubrication) as well as on the vehicle (revision of the wheel sets). Added to this are the operational problems caused by the non-availability of rolling stock and, more importantly, the increased noise pollution for people and the environment due to the rail squeal.

To deal with these problems in a coordinated, systematic way, the Federal Office of Transport (FOT) commissioned RAILplus to develop a strategy for tackling the problem in both the short and long term. In addition to carrying out research and basic groundwork, RAILplus would also prepare an education campaign. The information obtained will be made publicly available to all metre-gauge railways as well as to other interested parties. The findings will also to be incorporated into a set of technical regulations (RTE) that is currently being developed under the auspices of the Association of Public Transport (VöV).

The work is being administered and funded by a temporary systems leadership. This is the first time that an organisation, rather than a railway company, has been entrusted with the steering group function.

On the following pages, dear readers, you will find important information about the vehicle-track interaction governance board. We hope you enjoy reading it and will be happy to answer any questions you may have.

Yours sincerely,

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Joachim Greuter Managing director RAILplus, head of management board

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## SYSTEMS LEADERSHIP "METRE-GAUGE VEHICLE – TRACK INTERACTION"

The vehicle/track metre gauge system is under pressure, with higher axle loads, higher power levels and higher maximum speeds than ever before. At the same time, there is increasing urgency to keep costs under control when procuring rolling stock. The infrastructure's answer is harder rails and concrete sleepers. As these simplifications suggest, the complexity of the interaction between different materials, the different design of the vehicles and the track as well as the diversity of operating conditions is is enormous. However, a balance must be made between the speedy provision of solutions and sustainable, basic scientific work. There is, understandably, a great deal of short-term pressure to reduce the cost of maintaining vehicles and the track. Furthermore, the right system decisions must be made for the many impending track renewals (up to 50% of the networks). One of the greatest challenges for the systems leadership programme is locating the information about the interaction between vehicle and track, which is only sparsely available internationally, and applying it usefully to the metre-gauge railway situation.

The technologies available to us today allow us to carry out simulations that will enable us to draw the correct, commercially prioritised conclusions so that we can make recommendations on the optimal vehicles and track systems.

We are looking forward to this unique opportunity to develop and enhance the entire system and to make a valuable contribution to the knowledge management of the system and its overall commercial success.

Author: Markus Barth



MARKUS BARTH Interaction, head of technical board

The pragmatic proximity between vehicles and freedom from interoperability constraints puts our metre-gauge railways in an excellent position to optimise the overall railway system both commercially as well as technically. The FOT's mandate affords us the opportunity to tackle one of the railway system's most exciting but also most challenging optimisation issues. In doing so, we can rely on the support of the railway companies, the industry as well as experts from Switzerland and abroad.



## KNOWLEDGE MANAGEMENT



The railway system is very diverse, sometimes rather complex but not really a mystery. However, in order to achieve an impact in the system, an understanding of the system's interrelationships is essential. In order to strengthen this knowledge integrally, the Association of Public Transport (APT) has launched the Rail Technology Education (BTE) programme. Our vehicle/track systems leadership will be involved and will be supplying information about the vehicle/track system, obtaining it where it is not available and safeguarding it for the long term. It will therefore be necessary to localise the knowledge that exists in Switzerland and internationally, to adapt it for the metre-gauge system and to make it available in a suitable form. The APT will supply the necessary railway technology regulations (RTE) on the basis of the formulated principles. To be sustainable, however, it will also be essential to increase the knowledge carriers at the RAILplus railways. Six railway companies have already agreed to recruit and support young employees, who will make 50% of their time available for system tasks over the next few years. This will allow young researchers to be trained, networked and to feed the knowledge back to the companies. A model for success is already emerging today. There was a brisk demand for the system places. We are therefore convinced that we will continue to be an attractive industry if we succeed in stimulating the curiosity of the next generation.

#### AVAILABILITY OF EXISTING AND ACQUIRED KNOWLEDGE

The existing basic knowledge and the knowledge gained in the projects will be collected and made publicly available to the industry. At the same time, training and information events will take place. Recommendations will also be included in the technical railway regulations (RTE) published by the Association of Public Transport (APT). With the help of collaborative project work, long-term partnerships will be created with both universities and industry in order to cultivate and promote knowledge about interaction in the railways/industry/universities triangle.



"You have a seat on the management board as a representative of the Swiss Association of Public Transport. What do you think the value of the systems leadership on interactions is for the rail industry?"

The systems leadership on interaction is of huge importance. For the APT, it is particularly important for the railways to be able to effectively counter the operational and technical effects of the accelerated expansion of the railway in order to maintain cost-effective operation. The APT supports the systems leadership on interaction via its network and will make the findings from its research projects available to the industry in its compilation of technical railway regulations (RTE). We urgently need to expand our internal expertise in a targeted manner to ensure that the railways have the specialists they need for their work in the sector in the long term. The systems leadership on interaction will make a significant contribution to this.



**NIKOLAUS RITTER** zb Zentralbahn AG, project manager "Vehicle-track Interaction"

# "Mr Ritter, you entered the railway industry after leaving university 3 years ago. What has been your experience and what advice would you pass on to young people about to enter the engineering profession?"

My introduction to the world of the railway was actually my master's thesis on the non-destructive testing of wheelsets, which I was able to do in cooperation with SBB at the Olten plant. Fortunately, SBB advertises these diploma theses on its website. A diploma thesis with an industrial partner is an ideal way of learning the practical relevance of all the (important) theory – especially for students with a secondary school background. The railway world has a lot to offer students in many subjects that are not specifically linked to the railway industry, as I found out when I completed my SBB traineeship.

As a trainee, I developed a keen interest in in vehicle-track interaction. I found the physics and technical complexity of the subject fascinating. Luckily, I was able to find a job with the Zentralbahn in exactly this field. I think the fact that the systems leadership pays 50% of junior engineers' wages helped. Working in systems leadership is very demanding because I have a lot of responsibility junior project manager and can make a lot of things happen.

Although the railway has been around for a long time, it has always evolved: the chugging steam train is now a high-speed electric train, much like the wall-mounted dial telephone has evolved into the smartphone. And I know that this development work continues today. Mobility is a valuable commodity, in my opinion, and an attractive product that is worth working for because a tremendous amount of work goes into ensuring that a train arrives at the platform on time.

# **ORGANISATION** OF THE STEERING COMMITTEE

The organisation is structured in accordance with the timeline and the technical challenges. The objective of projects 1 and 2 is to provide knowledge quickly and to develop medium-term solutions, while projects 3 to 6 are more long-term and foundational in nature.



#### FREDI SCHÖDLER Baselland Transport AG, Deputy Director, Member of Project 6

"You are working on overall costeffectiveness project within the systems leadership. Why is that important to you personally?"

The interaction, or in other words, the technical coordination of infrastructure and vehicles is the basis for ensuring that both systems enjoy a service life that is as long as possible at the lowest possible cost. This requires close coordination between these two areas. Since the introduction of the rail infrastructure fund, the allocation of costs between the infrastructure and the bus and /OV has been clear. Here, the optimal overall cost-effectiveness of both must be presented in an overall view.

#### "Are you looking for tram/metregauge collaboration in the interaction?"

Yes, I believe we can benefit from each other.

## WHAT THE GOVERNMENT AUTHORITIES HAVE TO SAY

#### "What challenges do you see in the interaction between track and vehicle?"

The interface between the wheel and the rail has always been an Achilles' heel for the railways: the vehicles are supported by an area of no more than a few square millimetres, which has to absorb a lot of pressure, must be neither too hard nor too soft, and must not create noise on bends. Modern rolling stock is also becoming heavier, because it is being built to be more comfortable. Steel is now reaching its physical limits, which is resulting in a wide variety of damage to the wheel and rail. The newly launched programme has the challenging task of preventing this damage while at the same time optimising operating costs.

#### "Why, for the first time, was the systems leadership not given to a railway company?"

The problems mentioned are systemically important and have occurred simultaneously on several different railways. They therefore need to be addressed together. Moreover, a great deal of technical knowledge is required here, which can only be obtained in collaboration with all the railways concerned. Because the project is restricted to metre-gauge railways, it was obvious that RAILplus would assume the leadership role here.

### "What work in the system task is particularly important to you?"

The main task of a systems leadership is to find solutions that apply to more than just certain individual railways. It is therefore important to the FOT that the existing body of knowledge is collected and taken into account, that the approaches to solutions are developed collaboratively and that the results obtained are ultimately made available to the entire industry.



**Rudolf Sperlich,** Federal Office of Transport, head of safety department, vice-director, chairman of the steering committee

## THE 6 PROJECTS IN BRIEF

#### PROJECT 1 BASIC SURVEY

In Project 1, the main body of current knowledge will be compiled nationally and internationally, and missing knowledge identified. An industry survey will be used to localise and prioritise the pressure points and to determine the basic requirements of the operating conditions. These will be of great importance in later simulations and the associated impact assessment. Existing knowledge will be made available to the industry to serve as the basis for the RTE 29051 "Interaction Metre Gauge" to be prepared by the APT.



Top-of-rail conditioning (RC)



#### PROJECT 2 RC / WFL

In Project 2, the basic principles of metre-gauge top-of-rail conditioning (RC) and wheel flange lubrication (WFL) will be developed. The network-wide, optimised and combined use of the two systems will be evaluated.

- Rail conditioning will be used to minimise wear on the wheel flange and rail head flank when negotiating tight curves. Particularly in very narrow curves (< 250m) with very high wear potential, the requirements for WFL differ from those of the standard gauge.
- RC is currently used selectively on tight curves to eliminate cornering screech and is currently being trialled to reduce wear and damage to the frictionally engaging surfaces of the wheel and rail. There are currently no specifications or regulations.
- Since no track-protecting vehicle designs are expected to be available for the narrow curves in the near future, the following knowledge is to be developed in the project in order to achieve results quickly:
  - Metre-track-specific specifications for the use of WFL and RC in tight and very tight curves. This applies both to the composition and the choice of lubricants and conditioners as well as their application.
  - Reduction of noise (curve squealing) through targeted use of WFL and RC. In order to do this, the mechanisms that cause curve squealing must be understood.
  - Reduction of wear and damage to wheel and rail/track in tight curves.
  - When WFL and RC are used in parallel and possibly also network-wide, any combination effects must be known and controlled.

• Friction management will be introduced. The findings on friction and wear from Project 2 will be take up by Project 3 and the findings on system installation and application will be taken up by Project 5.

#### PROJECT 3

#### WHEEL/RAIL FUNDAMENTALS

In Project 3, the fundamentals of wheel/rail interaction in metre-gauge railways will be developed. More specifically, the running behaviour of the vehicles will be examined from the point of view of wheel/rail contact in tight and very tight curves as well as on straight tracks. The findings will be used as the basis for the further development of vehicle designs aimed at achieving an economical and low-wear vehicle – track interaction. The project will work on the following:

- Geometric, contact geometric, contact mechanical and systemic interaction of wheel and rail on the metre-gauge railway.
- Hardware and software for capturing, evaluating and validation the interactions
- Carry out running gear specification and verification calculations and validate these by means of tests on a track.
- Carry out proofs of sustainability by means of operational trials (in comparison with the other projects).

The findings on friction and wear from Project 3 will be passed back to Project 2. Project 3 also acts as the interface between Projects 4 and 5 and must provide both projects with the fundamental data they require.



#### ROGER AERSCHMANN

Transports publics fribourgeois, head of infrastructure, member of the management board

### "What role do the different national languages and cultures play in the success of the research project?"

I think the best place for the tpf is as a mediator between the infrastructure assets of the standard and metre gauges in the language regions for the benefit of the research project. After all, half of the metre-gauge railways are located in the French-speaking part of Switzerland. This role as a mediator between the languages can help everyone to communicate better. The fact that the knowledge needed for ongoing development is exchanged between everyone is a particularly big benefit, with new technologies being introduced together.



#### GERHARD ZÜGER

zb Zentralbahn AG, head of production and rolling stock, member of the management board

#### "As one of the key co-initiators, you have been involved with the issue of interaction for a long time. Why is it so important to you?"

The railway system is very resilient; many changes can take place without having a major impact. The current problems with the interaction between the vehicle and the track indicate that the system is beginning to struggle. The result is an increase in the costs of maintaining the vehicles and the infrastructure together with a decrease in their availability. It is time for the railways to seek a sustainable solution, and I am personally committed to this aim.



#### PROJECT 4 TRACK STIFFNESS

In Project 4 the interrelationships of the ballasted track are shown in a dynamic vehicle-track-model. To construct the model, the flexible components of rail pads, under sleeper pads and under-ballast mats will be examined for their effects (reduction of noise/vibration as well as LCC) within the track stiffness. The following knowledge will be developed:

- An understanding of the dynamic system and characterisation of the flexible components.
- Practical validation of the vehicle-track-model.
- Recommendations for the design of the track system, as "Best Design LCC Track System Interaction Metre Gauge".

The challenge is to make basic recommendations as soon as possible so that the extensive track renewals scheduled for the next few years can be carried out in an LCC-optimised manner.

#### PROJECT 5: VEHICLES

The aim is to be able to make a "Best LCC Design Vehicle Interaction Metre Gauge" recommendation in cooperation with the industry. The basic knowledge acquired from the wheel/rail project will enable us to draw the right conclusions for the overall design of future vehicles but also for modifying existing vehicles, to increase the overall cost-effectiveness of the system. The optimal design (priority) of the metre-gauge running gear will be determined by means of simulations and a possible validation by a test vehicle, taking account of the operating conditions. A vehicle design optimised for the metre gauge should exhibit impressive low wear running behaviour in tight curves and show a good performance at higher speeds (120 km/h) in straight lines. The project aims to develop the following knowledge:

- Assess the most important design parameters and the related basic concepts with regard to LCC behaviour.
- Simulation models to demonstrate compliance with the physical requirements of bogies regarding behaviour in tight curves and safe and secure control at high driving speeds in straight lines.
- Validation of the findings on prototypes.

#### PROJECT 6: OVERALL COST-EFFECTIVENESS

The main objective of Project 6 is to identify the commercially optimum vehicle/track system, depending on the conditions of use, in the overall life cycle. Here, the interaction (primarily wear) of the vehicle subsystems and track within the current system will be analysed (zero variant). In a second step, future technical and operational solutions will be evaluated economically, and recommendations made. Savings will accrue from more extended maintenance intervals and maintenance cycles, with maintenance carried out according to condition and adequately monitored, as well as in accordance with the fact-based economic efficiency considerations of the overall system.

The project will work on the following:

- Determining the development of costs for selected railways in the vehicle/track system
- Plausibility checking by comparison with knowledge about the standard gauge.
- Analysis of cost trends and identification of cost drivers in the system.
- Identifying control mechanisms and their effectiveness.
- Showing overall economic effects such as, for example, reducing maintenance work on one or more system components.





IVAN PFAMMATTER Matterhorn Gotthard Bahn, Head of rolling stock, member of the management board

"It's no secret that Matterhorn-Gotthard-Bahn (MGB) is struggling with a rise in damages. What are you expecting from the national research project?"

My expectations are clear: to restore the balance between wheel and rail and improve the availability of the track and vehicles. Experience sharing – one of the main pillars of RAILplus – is being allocated a key role. This not only gives the issue an industry-wide dimension but allows us all to benefit from the extensive specialist knowledge available within each railway company.



#### CHARLES RUNGE

Montreux Oberland Bernois Railway SA, head of rolling stock, member of the management board

"The Montreux Oberland Bernois Railway is getting ready to order more rolling stock. What challenges do you see for yourself and in collaborating with the industry?"

The biggest challenge lies in making sure that the rolling stock division is ready to provide an optimal level of maintenance. The expectations of the industry are similar: to be a competent dialogue partner with the goal of reducing the overall costs of the railway system. In future, LCC costs will be a decisive factor in awarding purchase contracts.

## 1+1=3 RAILPLUS CREATES ADDED VALUE

RAILplus was founded in 2003 to strengthen cooperation between the smaller railway companies and play an active role in the public transport landscape. Converted into a public limited company in 2005, RAILplus grew to become a group of ten – mostly German-speaking – Swiss railway companies. With the addition of the Western Swiss and Ticino railway companies between 2018 and 2020, RAILplus AG has expanded into a group of 20 metre-gauge railway companies covering a network of 1400 kilometres, or a quarter of the Swiss railway network.

This cooperation platform allows the participating railway companies to benefit from synergies in many areas as well as from shared services such as purchasing, training, cybersecurity, etc. Exploiting this synergy potential increases the commercial efficiency and competitiveness of the member companies. RAILplus also represents and promotes the interests of its members towards the various authorities and associations. The Society also carries out best practice analyses and regularly lobbies regulatory and funding authorities, drives innovation, and creates centres of excellence.

The working groups, which are organised by subject area, aim to benefit from each other's expertise and the available synergies. The managers meet regularly to discuss their current issues and to work on finding common solutions. This open sharing of experience by all specialist areas at all levels is critical to the success of the working groups. In the context of the systems leadership on interaction, the working groups also offer an ideal platform for communicating and cross-checking the results with the railways.

The map below shows the RAILplus route network. We are also pleased to include Baselland Transport (BLT), the Forchbahn (FB) and the tramways in the systems leadership.

#### IMPORTANT CONTACT DATA

RAILplus 5001 Aarau Phone: 062 561 41 41 www.railplus.ch **Head of management board:** Joachim Greuter, joachim.greuter@railplus.ch **Head of technical board:** Markus Barth, markus.barth@railplus.ch



#### **PUBLISHING INFORMATION**

**Publisher:** RAILplus AG | P.O. Box | 5001 Aarau | info@railplus.ch | www.railplus.ch | **Managing Director:** Joachim Greuter **Layout:** Top Line Marketing | **Languages:** German / French / English / Italian