Track Systems & Infrastructure

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Building a seamless European rail infrastructure for the future

The European Union’s vast railway infrastructure reaches from Lisbon to Vilnius and from Glasgow to Athens, totalling more than 200,000km in length and crossing various national borders with conditions ranging from poor to offering excellent high-speed suitability. But as rail customers continue to define new needs which places demand for more and new services, the Community of European Railway and Infrastructure Companies’ Executive Director, Libor Lochman, and Senior Advisor, Enno Wiebe, explain that a significant leap forward is needed to make rail infrastructure both competitive and fit for the 21st century.

The European rail system was developed on a national basis and has undergone historic economic ups and downs. Presently more than one million employees ensure the day-to-day running of the system and aim to be prepared for the challenges of the future.

Europe’s railway infrastructure – a large variety

Europe’s railway infrastructure is characterised by its huge diversity, both technical and structural. The majority of the conventional network was built applying 19th century design parameters whilst some lines were adapted to 21st century demands through upgrades. In addition, a system of newly built high-speed lines has emerged. The rail network in Europe consists of various gauges, signalling systems and voltage systems, which differ not only from Member State to Member State, but even within the territory of a single Member State. Railway infrastructure specifications and each of their exceptions to the rule, in consequence of historic reasons, read like a closed book. In order to
decrease the costs of Europe’s rail infrastructure, a thorough harmonisation and simplification programme is needed.

The European transport system as a whole is constantly and progressively evolving as customers define new needs and demand new and greater services. The railway system and its infrastructure need to comply with these future challenges in order to allow the rail sector to stay competitive. A significant leap forward is needed to make the rail infrastructure fit for the 21st century.

Future rail infrastructure – intelligent and safe
The rail system infrastructure of the future must be designed to be intelligent and safe. Intelligent infrastructure will be fatigue- and wear-resistant as well as energy efficient, with system components being monitored autonomously in real-time. The use of new operational and track-engineering techniques across the network will reduce the need for intrusive maintenance and greatly improve train/infrastructure interaction, such as the wheel/rail interface, at conventional and high speeds.

Bringing more passengers and goods to rail will require a significant upgrade of the existing system. The railway should be operated on a ‘forever open’ basis. Inevitably this will lead to a conflict with maintenance programmes on operated lines, as maintenance is normally carried out in shutdown periods. In order to avoid clashes, maintenance planning and scheduling must be optimised. Non-intrusive infrastructure monitoring can be followed up with innovative and fast maintenance, such as high-speed grinding.

Concentrating on intelligence provided by the system (remote condition monitoring) will enable the establishment of what, when and where maintenance is needed. This will ensure that system interruption has a low impact and product availability to the customer can be maximised.

Asset management tools will be developed that allow comparison of maintenance and/or replacement strategies for track and infrastructure based on traffic levels and whole-life evaluation.

The basic track layout for rail-bound vehicles might not completely change in the future. However, the main focus will be on optimising maintenance for ballasted tracks and the development of future slab track systems. Furthermore, the infrastructure limitations for heavy and long trains will have to be overcome.

Future freight terminals will have to be designed for swift throughput and loading and unloading of trains, with freight customers having easy access to terminals. Optimising processes for train preparation will increase efficiency while decreasing the noise and vibration, and therefore the social nuisance caused by terminal operations.

Shift2Rail – an ambitious work plan
Shift2Rail – as the first European rail joint technology initiative seeking focused research and innovation (R&I) and market-driven solutions – has drafted an ambitious work programme including cost-efficient and
A significant leap forward is needed to make the rail infrastructure fit for the 21st century.

reliable high-capacity rail infrastructure. A strong emphasis is placed on improved reliability and enhanced capacity, as well as lowering the investment and operating costs. The expectations to develop innovative track design (including tunnels and bridges) and materials (including switches and crossings) are high and the sector is waiting for solutions to be delivered that can be fully implemented in the existing system. Standalone solutions will not bring any breakthrough for the system as a whole. Shift2Rail will be of benefit for both the European manufacturing industry and the rail operating community. Maintaining Europe’s technologically advanced position will be key to retaining its competitive position at global level.

TSIs – the regulatory framework for rail

Whilst technical solutions can help upgrade the railway networks and make them fit for future challenges, a final issue needs to be reflected upon: the European regulatory framework for rail – in particular the Technical Specifications for Interoperability (TSIs).

TSIs refer to the specifications by which each subsystem, or part of a subsystem, is covered in order to meet the essential requirements and to ensure the interoperability of the European community’s rail systems. The ‘2014 TSI Infrastructure’ defines all the different aspects of the infrastructure subsystem including: line layout; track parameters; switches and crossings; track resistance to applied loads; structure resistance to traffic loads; immediate action limits on track geometry defects; platforms and health and safety. In addition, the ‘2014 TSI Energy’ includes parameters on voltage and frequency and geometry of the overhead contact line, among others.

The TSIs are a step towards harmonising the European rail system and the European railway infrastructure. They are a step forward but not a breakthrough. Various parameters remain different in the different Member States and, for some essential requirements, even different target systems were defined. These different target systems are due to historic reasons but should not be set in stone. For forthcoming TSI revisions, a migration towards a single target system should be determined, accompanied by a sound implementation strategy and a consistent and
Time to act

The European railway infrastructure will have to change systematically and substantially in the next decades. From a technical perspective, simplification and radical cost reductions are needed, as well as new, reliable components and smart maintenance. From a regulatory point-of-view, the definition of a single European target system is necessary in order to transform the European railway networks into a real Single European Railway Area. We cannot afford any further delays; now is the time for the railway sector to begin the complete makeover of its assets so that it will be in good shape to celebrate its 200th anniversary.

Our vision is ultimately one of a modern and cohesive rail system that can support vital pan-European rail corridors and intermodal links with other continents. Interoperability will fully ensure that trains cross state and operational borders without delays or operational constraints, offering a smart and competitive alternative to short and medium-distance flights and water and road-borne freight flows.

Libor Lochman has been Executive Director of the Community of European Railway and Infrastructure Companies (CER) since 1 January 2012. Libor graduated at the Transport University in Žilina and has a doctorate in electronics from the West-Bohemian University Plzen. He has a strong background in control-command and signalling systems. Prior to his role as CER Deputy Executive Director and Lead of Technical Affairs (2007-2011), Libor acted as Director of the Railway Test Centre – a facility for testing European rolling stock, infrastructure and signalling components in Prague (2000-2005). Libor joined the Editorial Board of European Railway Review in January 2013.

Enno Wiebe is Senior Advisor for ERA and research related issues at the Community of European Railway and Infrastructure Companies (CER). He is dealing with the Fourth Railway Package’s Technical Pillar and energy and infrastructure issues related to the Technical Specifications for Interoperability (TSIs). Enno is the CER representative in the European Rail Research Advisory Council (ERRAC). He is a civil engineer employed by Deutsche Bahn and seconded to CER.
The Gotthard Base Tunnel’s world-leading track technology

The Gotthard Base Tunnel in Switzerland is one of the most imposing structures ever built in the history of rail traffic – at 57km-long, it is the longest railway tunnel in the world and will be officially inaugurated in June 2016. Global player for rails and turnouts, voestalpine, has been a key supplier for this project.

Construction of the New Rail Link through the Alps (Neue Eisenbahn-Alpentransversal, or ‘NEAT’ in short) is creating a fast and efficient transit route. At its heart is the Gotthard Base Tunnel which is not only the longest, but also the deepest rail tunnel with a rock overburden of up to 2,000m.

The CHF 12 billion project is an extremely challenging and complex one from an engineering point-of-view. The new line will be characterised by an enormous frequency of up to 250 trains a day and by the fact that it combines high-speed passenger operation with heavy-loaded freight transportation. Considering the environmental conditions in the tunnel (such as ambient temperatures of up to 40°C and humidity as high as 70%) this altogether constitutes the ultimate challenge for mixed traffic tracks. Due to the expectable strong modal shift from road to rail, the Gotthard Base Tunnel also brings a crucial benefit in ecological terms.

It almost goes without saying that only the best materials and services had a chance to be selected on this construction project. Therefore each of the two single-track tunnel tubes is equipped with 120m ultra-long rails from voestalpine Schienen GmbH and high-speed turnouts from its sister company, voestalpine VAE GmbH. A special test train has...
already successfully operated along the finished tracks at speeds of up to 275km/h (10% above the design-speed). Other test runs are to be carried out with extra-long freight trains powered by three locomotives. The total number of test runs will be around 3,500 cycles before the tunnel is handed over to the Swiss Federal Railways (SBB).

On the whole, the project developed and materialised extremely successfully along a precise multi-year schedule, starting with the delivery of the provisional tracks by voestalpine that were used during the tunnel boring phase. Thus, a total of 28 million tonnes of excavated rock was transported out of the tunnel.

The next step was the supply of roughly 18,000 tonnes of rails and 43 turnouts which was accompanied by a service package including comprehensive engineering work, qualification tests, documentations and trainings. voestalpine experts not only had the demanding task to intensively accompany and facilitate installation, but they were also entrusted with carrying out special track work on-site themselves. Not surprisingly the turnouts feature top-notch technology – the HYDROSTAR® – a technologically advanced combined point operating, locking and detection system, as well as the IE 2010 (internal end position detector).

Although without any doubt constituting a highly prestigious lighthouse project, this is only one of voestalpine’s many achievements in the tunnelling business.

In 2013, voestalpine won the contract to supply the new rails for the Channel Tunnel – the 50km-long underwater section between France and Great Britain. In this project as well, intensive intra-group cooperation was called for to secure maximum customer benefit. The work involved the rail producer voestalpine Schienen GmbH, and the rail centre voestalpine Railpro BV in the Netherlands plus voestalpine France. While the rails were rolled in the Austrian high-tech mill, the Dutch took care of the welding and coating (a special service to counteract corrosion) and supplied the rail strings by long welded rail trains to the destination including unloading.

In Switzerland, the voestalpine Group’s ‘track record’ of excellence includes, for example, the Lötschberg Base Tunnel (opened in 2006 and having a length of almost 35km). Both the rail and turnout business units look forward to also supplying for the Ceneri Base Tunnel which is more than 15km-long.

Journey times between Zürich and Milan will be cut from 4 hours to 3h30 when the Gotthard opens, and to 3 hours when the Ceneri Base Tunnel opens in 2020. The aim is to manage train traffic down to intervals of just 3 minutes on this environmentally-friendly route through the Alps.

It is no surprise that voestalpine also has eyes on other projects such as the Brenner Base Tunnel which will be the main element of the high performance railway from Munich to Verona and will connect North and South Europe much more efficiently than it is possible today; even longer than the Gotthard, the construction project will be a pioneering work of engineering to markedly improve passenger travel and freight transport through the heart of Europe.

In a nutshell, all this confirms once again that operational track availability is of paramount importance when it comes to high performance (defined as the combination of substantially extended service-life and drastically reduced maintenance interventions, of course without compromising on other factors such as safety). In this connection, voestalpine also fully welcomes the European-wide implementation of the so-called ‘MEAT’ principle (the ‘most economically advantageous tender’ as required by the applicable EU Commission Directive on Public Procurement). Accordingly, all public contract awards are to take place on the basis of a lifecycle cost analysis and may also take into account other criteria such as CSR (corporate social responsibility).
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Fostering innovative infrastructure maintenance

EIM, the association of European Rail Infrastructure Managers, promotes the interests and views of rail infrastructure managers in Europe. With 12 members and two associate members, EIM represents over 50% of the EU’s railway lines. EIM members have a key role in developing, operating and maintaining the European railway network. But how will research and innovation shape future maintenance processes? EIM’s Executive Director Monika Heiming and Technical Affairs Manager Ville Saarinen take a look.

Maintenance with a holistic approach
Rail infrastructure managers have to offer safe, reliable and cost-effective track systems. As part of this mandate, they approach maintenance in a holistic manner, due to its interrelationship with the entire life-cycle of infrastructure management: funding, building, operations, maintenance itself and innovation.

Apart from impacting on their overall asset management, maintenance is also key in the performance of the infrastructure manager to deliver services to its customers. Hence, maintenance is one of the key functions of any infrastructure manager, and it will be amongst the first functions to be innovated and digitalised which is already being addressed in several EU initiatives.

Maintenance in EU legislation
Over 80% of national rail regulations find their origins in Brussels (BE) within the European Commission, or in Valenciennes (FR) as part of the European Railway Agency (ERA). ERA was set up to help create a safe and interoperable single European Railway Area via Technical Specifications for Interoperability (TSIs) and Common Safety Methods (CSM).

Infrastructure managers are involved via their sectoral body
EIM (European Rail Infrastructure Managers’) in the preparatory works of these TSIs and CSMs while providing feedback on the experience from implementing them. A well drafted TSI and the accompanying Application Guide lays the foundations for an increase in cross-border traffic and a reduction in operational costs.

EIM provides a platform for its members to exchange experience working with the TSIs and to improve their implementation. The current objectives and focus of EIM’s Technical Working Groups is to improve interoperability throughout the Union by closing the TSI open points with ERA in a cost-effective way. This objective is actively monitored and directed by the EIM Technical Steering Group in terms of EIM’s daily operations.

One of the most relevant TSIs regulating maintenance and construction of track systems is the ‘Infrastructure TSI’, which covers:

- Items related to track building and maintenance
- Interfaces with the other subsystems and TSIs
- Interoperability constituents subject to the EC verification in this subsystem, i.e. the rail, the rail fastening system and track sleepers.

EIM members, via EIM’s Infrastructure Technical Working Group, have actively participated in the drafting of the currently applicable Infrastructure TSI which came into force 1 January 2015, bringing together the two former Infrastructure TSIs for conventional rail (CR) and high-speed (HS).

EIM’s members have also influenced the content and drafting of the Infrastructure TSI Application Guide, published on 14 December 2015. A poor Application Guide could reduce the effectiveness of the TSI and cause a divergence in the national railway systems which should be heading towards interoperability. In addition, in some cases it may lead to unnecessary costs resulting from the execution of works not required in the TSI.

Trimble GEDO Scan –
light-weight mobile laser-scanning system for clearance checks

The GEDO Scan track measurement system is a mobile and flexible solution for railway clearance. It uses a laser scanner to collect high-resolution 3D datasets. The scanner is mounted on a GEDO CE 2.0 track measurement device which collects position, gauge and cant information as it moves along the track. This device has been successfully used for many years in configurations such as GEDO Rec for track surveys and GEDO Track for slab track construction and as built check. In the GEDO Vorsys twin-trolley configuration it is used for high productive pre-measuring for tamping and track survey.

Trimble GEDO Scan enables a kinematic asset data collection for all objects close to the track. The resulting 3D point cloud enables further processing and data extraction.

The GEDO Scan system can operate in two modes: Local Mode for clearance analysis captures information based on the offset from the rail to nearby objects, and in Absolute Mode, the system can create 3D point clouds in a defined coordinate system and tie objects to the rail. In this mode the system is combined with geodetic sensors (GNSS or Total Station).

For 3D railway visualisation and analysis, Trimble GEDO Scan Office uses clearance envelopes and 3D models to simulate the movement of a railcar through an existing facility or stretch of track. The system can automatically detect locations where clearance encroachments may occur.

For detailed analysis, Trimble GEDO Scan office can create cross section drawings and compare differences according to given profiles or envelopes. Smooth data flow and straightforward data processing and analysis guarantees high productivity. Special export formats (e.g. Clearroute and WinLUE) are available to stream data into track clearance databases.

www.trimble-railway.com
Maintenance trends
Maintenance impacts the entire life-cycle of infrastructure management and it is also one of the largest cost drivers, making up some one third of the railway’s operating costs. Hence, mono- and multi-modal benchmarking, innovation and automation, predictive vs corrective or time-based maintenance will gain in importance for infrastructure managers to forecast the optimal time and way for maintenance and renewals.

Research and innovation will substantially shape current maintenance processes. A few of them include:

Automation
EIM is engaged vis-à-vis the European Standardisation Organisations to foster more innovative maintenance. In many countries, EIM members have installed advanced wayside monitoring equipment to monitor the condition of their customer’s rolling stock operating on the network. So far, the identification of individual rolling stock was a time and resource-consuming process and the lack of automation did not allow compiling of effective condition reports. In the future, wheel defect evolutions can be identified to limit track damage and help speed-up corrective measures. The same applies to unbalanced or overweight axle loads impacting the safety of the track.

To address these problems, but also others, EIM is pushing for a standard for the Radio-Frequency Identification (RFID) in rail via the CEN process. EIM and the Finnish Transport Agency (FTA) will organise a kick-off meeting on the topic at the end of March 2016 in Brussels under the CEN umbrella.

Ultimately, automation will help the infrastructure managers to develop better deterioration models of their networks, thereby fostering safety and asset management of their tracks.

Resilience
Maintenance is also crucial in terms of contingency and congestion issues on the network following increased traffic or adverse weather conditions (torrential rainfalls, extreme winter or summer conditions). Both issues are addressed in EIM for rail but also across infrastructure modes.

In fact, being subject to adverse winter conditions, many countries design at least part of their system with a temperature range starting from -40°Celsius to +30°Celsius in the summer. This means, for example, that the tensioning devices of the catenary system are built to accommodate this temperature variance. The neutral temperature of the rails also reflect this by being lower in the Scandinavian region than in Central Europe. This detail showcases the difficulty in delivering a truly harmonised European single railway area.

These issues will have to be addressed from the supplier’s side as well. Their components and systems need to have a more modular and interchangeable design approach helping the infrastructure managers to improve the system’s down-times in the case of disturbances.

EIM’s overall objective is more interoperable components in order to widen the supplier base and offer for its members; new actors, as IT companies have already seized this opportunity.

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Amberg Technologies has expanded its established railway surveying system GRP System FX with the new Amberg IMS 1000 and IMS 3000 system configurations. With this technological milestone, railway surveying has never been easier and more efficient.

These configurations provide reliable and highly precise track geometry information during the construction and maintenance of railway track systems – while achieving unparalleled productivity. Amberg IMS 1000 and IMS 3000 measure the inner and outer track geometry of ballast tracks and slab tracks using a new, high-performance sensor – the Inertial Measurement Unit (IMU). Measuring 4,000m of track per hour, the system’s performance is twice as high as other devices available on the market today. Furthermore, it ensures that the track will be measured reliably by providing a typical positional accuracy of ±1mm.

“With this system we set a new standard for the speed of hand-pushed measurement carts while at the same time achieving the greatest accuracies,” explains Marius Schläuble, Product Manager Rail at Amberg Technologies. The Amberg Rail software, which is also the platform for Amberg IMS 1000 and IMS 3000, processes the measurement data, analyses the quality of the track and reports the deviations to a design centreline. Correction data for tamping machines can also be generated directly. The advantage for the system’s users is that greater productivity and accuracy during track measurement reduces costs, enables efficient track maintenance and thus contributes significantly to the quality and safety of railway lines.

The new IMU technology replaces the tachymeter for measuring track geometry and therefore only requires a single measurement cart, operated by just a single operator. Until now, up to four people were required for comparable track geometry surveys. The ‘Track Sprinter’ also requires minimal logistical effort and can be used flexibly and at short notice, ensuring the costs for track geometry surveying decrease up to 90% compared to traditional methods.

Thanks to the IMS 1000 and IMS 3000, Amberg Technologies is further extending its leading position in developing high-performance measurement systems for rail construction and maintenance. “We continuously work on improving the technology and functionality in order to optimally meet the increased market expectations,” says Marius.

R&D on EU level (Shift2Rail)
The Shift2Rail (S2R) Joint Undertaking brings together the EU and the rail industry via a public-private partnership.

S2R has identified: a) the aging infrastructure; and b) the increase of railway traffic as key challenges for the European railway system.

Furthermore, the existing station and terminals are reaching their maximum capacity in certain areas while the quality of the surroundings do not match customer’s expectations. An increasingly important factor for the attractiveness of the railways is a functioning intermodal approach with a flawless multimodal passenger and freight transport chain.

Until 2025, members of S2R will address these issues. Infrastructure maintenance and innovative construction will be covered in S2R’s innovation program (IP) 3 – Cost Efficient and Reliable High Capacity Infrastructure, also involving members of EIM.

Individual approaches
Individual members of the EIM address maintenance in parallel to the EU initiatives. Several of them have embedded innovative maintenance into their digital strategies, in order to be able to collect large amount of often non-digital data in order to analyse them for modelling and clustering with other functions. These processes are often coupled with investments in fixed assets and devices for automatic monitoring, supervision and data handling.

Over time, applications such as self-alerting switches or interconnected devices related to weather forecasts or automated maintenance planning will develop.

Conclusion
Maintenance is a key function for the life-cycle approach of rail infrastructure managers. It will be amongst the first functions to be innovated and digitalised. EU and individual research and innovation initiatives will foster this process. Overall, maintenance is key for a more resilient, predictive and safe infrastructure, able to host for future traffic growth.

EIM addresses these trends via several activity vectors, both within its organisation but also with several external stakeholders and partners.

References
1. www.emrail.org
3. www.shift2rail.org

Monika Heiming has been Executive Director of EIM since October 2011. Monika has been active in Brussels as a lobbyist and manager of international associations and groupings for a number of years. She studied languages at the University of Cologne, and holds a Master’s degree in European Management from the University Faculties in Brussels and an Executive MBA from the Belgian Solvay Business School. Among her previous experiences, she helped develop UNIFE in Brussels from 1993 to 1997. She also managed and marketed the engineering activities of European engineering group Europengineers EEIG from 1999 to 2004, before being made Secretary-General of ERFA in January 2005.

Ville Saarinen is Technical Affairs Manager at EIM. He holds a Master of Science in Electrical Engineering and has a background in railway electrification, tunnel safety and dangerous goods. His specific fields of interest are railway interoperability and safety. In addition to his role in coordinating the EIM technical activities vis-à-vis the relevant EU institutions, Ville is actively involved in the European railway standardisation via the CEN/CEI/OLEC process. During his career, Ville has applied the EU legislation in practice by consulting transport ministries in implementing the railway interoperability and safety directives into their national laws.
In an ever faster moving world, railway operators must meet increasingly stringent demands. With freights getting heavier and passengers more demanding, there is simply no room for delays or failures. Not only does voestalpine develop rails and turnouts from a single source, but also to meet the highest imaginable standards. The result: double the durability at half the life-cycle costs, with worldwide availability and just-in-time delivery for good measure.