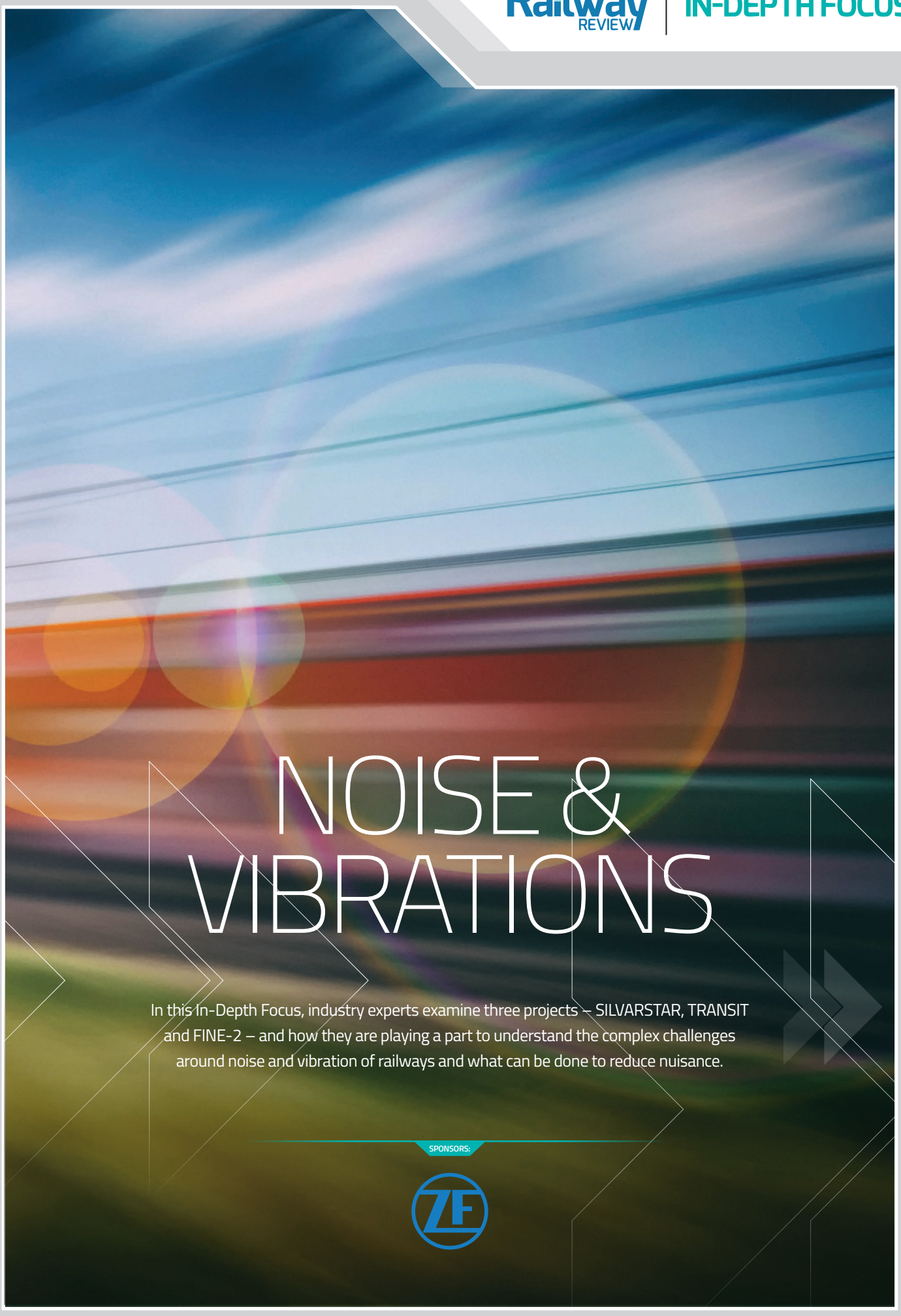


NOISE & VIBRATIONS

In this In-Depth Focus, industry experts examine three projects – SILVARSTAR, TRANSIT and FINE-2 – and how they are playing a part to understand the complex challenges around noise and vibration of railways and what can be done to reduce nuisance.

SPONSORS:

ZF

Noise and vibration work in the **FINE-2 project**

In situ noise recording, performed in Crespin, France (July 2021).

Scott Heath, Coordinator of the FINE-2 project, details the project's work around rail sector noise and vibration, and how its dedicated work packages, in conjunction with TRANSIT and SILVARSTAR, are seeking to comprehend, in fine detail, the sound generated outside of the train.

THE FINE-2 PROJECT is a perfect example of the European Commission's (EC) Horizon 2020 funding being used as it was intended – to promote collaboration in Research and Innovation activities in order to achieve greater impact. It is a collection of 14 organisations, located across seven countries, whose business activities range from train operators and infrastructure managers to research institutions and supply chain partners.

As part of the Shift2Rail Programme, the ca. €940 million public private partnership delivering research and development over a seven-year period, we interface significantly with other EC funded projects. This engagement is both circumstantial, as many of the participants are involved in other Shift2Rail work, as well as by design, as we recognised the need to work with specialist organisations outside of our consortium

Above: *In situ* noise recording, performed in Crespin, France (July 2021).

in order to achieve our goals. This is evident through our activities in the noise and vibration (N&V) domain, which this article will discuss, where we are working with two other consortia, TRANSIT[1] and SILVARSTAR[2].

Before discussing the details of the FINE-2 work on N&V, it is worthwhile noting the final part of collaboration that exists in the project – that which is internal. We are the combination of three sub-projects (termed work streams), each constructed of four or five discrete Work Packages (WPs). This means that experts from different domains come together to share their insights and offer best practices approaches to challenges that can be encountered.

The first work stream is focused on Energy and it seeks to help standardise the way in which energy consumption of trains is evaluated. The middle work stream (WP6-WP10) is N&V, with the final being termed 'Integrated Mobility Management' or I2M. These I2M WPs are looking at the technical integrations that are needed to enable more freight transportation in a rail ecosystem that uses traffic management systems (TMS), as well as other business benefits that can be derived from interfacing TMS with other data sources.

Our work in the N&V domain is focused on improving our understanding of the sound generated outside of the train. As the name Shift2Rail suggests, the main objective is to encourage a modal shift of travellers from cars to trains. Noting this you may wonder why our work is looking at impacts external to the train carriage. After all, if we reduce the sound generated by a train passing a line-side neighbour, will it really increase the usage of trains? Rüdiger Garburg, technical leader of the work stream, provided a clear answer to this challenge: "*We are going to need to keep improving the railway to attract customers, and some of this will involve construction. In democratic systems you need the support of local people to make these changes, otherwise everything will be harder to do. We get their support by demonstrating clear improvements, and one of the best ways to do this is to say: 'we are making this railway line so many decibels quieter' or 'we can guarantee trains passing will generate fewer vibrations'.*"

To help provide tangible and reliable benefits from train and infrastructure enhancements, the work stream is supporting the generation of new modelling tools that are developed by the SILVARSTAR project. This technology will be a step change in those available today and the first of its kind to be railway specific. Alongside this, we are hoping to reduce the costs and improve the processes associated with rolling stock acoustic certification by enabling it to take place in a virtual environment. This would also reduce the time to market for newer trains. This objective is being achieved by working with the TRANSIT project.

WP6 – Exterior Noise Validation

The first N&V Work Package is WP6 – Exterior Noise Validation. This is where the activities necessary to support the virtual certification are taking place. The partners of the WP are providing access to rolling stock and the infrastructure needed to undertake sound measurements. Both manufacturers and operators in FINE-2 and partners in the TRANSIT project will perform these. Following this, the simulation tools will be constructed then validated.

WP Leader Rita Caminal Barderi explains more: "*We are studying several different types of noise that can be generated by equipment on a train.* »

SCOTT HEATH

Scott is the Coordinator of the FINE-2 project and employee of Thales Ground Transportation Systems in London, UK, where he leads on Research, Development and Innovation in UK Rail.

In situ noise recording, performed in Crespin, France (July 2021).

These range from electrical noise from motors to the cooling noise issued by a Heating, Ventilation, and Air Conditioning (HVAC) system. These all differ in their frequency and source directivity, so understanding them in isolation is vital in predicting how changes in train design can impact eventual sound emissions. It is not just the behaviour or volume of equipment that is important either. We know that the location on the train can also impact propagation. For instance, moving the HVAC from the under-frame to the roof can make the station environment much louder. We therefore need to capture data from multiple positions in order to model more accurately."

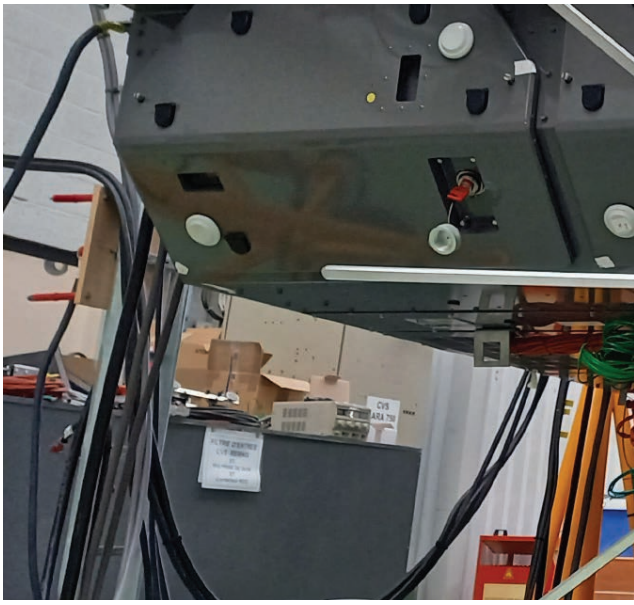
On site tests have already begun, with a successful campaign taking place in Crespin, France during summer 2021. Rita goes on to say: "*We are looking at six reference cases when a train is stationary. For each, the train equipment is measured standalone and again when installed on the train. We are using the standalone measurement values in the model, where the train geometry and other factors are also considered, and then validating the results generated by TRANSIT against the values we record when in situ. I am very hopeful that this approach will generate good quality results.*"

WP7 – Noise Source Separation

The main source of noise from the railway at conventional speeds is that generated by the wheels on the track, called rolling noise. WP7 looks at the factors influencing such rolling noise. "*We are supporting two activities,*" explains Ainara Guiral, WP7 Leader. "*The first seeks to improve the existing methodologies for separating the track and the train contribution in generating rolling noise.*" This separation is necessary, as the same train on different tracks will emit different noise, but it can be hard to ensure pass-by recordings are made on all types before deploying new livery.

Ainara continued: "*We are working with experts from research centres, universities, and specialist consultancies inside the TRANSIT project to enhance and simplify existing methods that could potentially be used in future certification procedures. It is quite unique to be working in a project where competing train manufactures are sharing this data – we have partners from CAF, Alstom, Siemens, and Talgo. This spirit of collaboration began in earlier EC projects (ROLL2RAIL and FINE1) and has continued into FINE-2.*"

It is also true that the speed of a train can influence the factors dictating noise emissions of the train. Ainara explained: "*The second activity we are supporting is the development of innovative techniques for separation of different acoustic sources, not just rolling noise, during the pass-by of a train. Traction noise and aerodynamic factors can also play a big part and we want to ensure they are*



understood too."

Three site tests will be conducted to characterise different tracks and take pass-by readings and these will be used to assess the models proposed.

WP8 – GGround Vibration

The eighth WP of FINE-2 is focused on Ground Vibration. Whereas WP6 and WP7 seek to improve upon existing models, rail vibration prediction and modelling is a gap in toolkit. WP Leader Sascha Hermann explained the work: *"We are working with the Shift2Rail Project SILVARSTAR to build a prognosis tool that can simulate and evaluate vibration propagation. This is in line with existing standards, such as DIN 4150, to ensure it can be used with confidence."*

WP8 is also demonstrating efficiency through collaboration. Sascha continued: *"We need site measurements to validate the tool. Instead of doing a separate set of readings for ground vibration, we are working with the other FINE-2 N&V WPs to use the same testing campaigns. Our approach is fairly standard. We have gathered requirements for the tool from both the infrastructure and operations side of the rail system and the train manufacturers. Our partners in SILVARSTAR are now working to build the models and refining the interfaces."*

It is expected that the final product will be able to provide both rough estimates for early stage feasibility discussions, as well as the detailed analysis of train-induced vibration needed to understand the impact inside buildings near the track. Sascha explained: *"One of the biggest challenges here is to combine our scientific findings with existing prediction models for the subsystems involved to make an easy-to-use software whilst ensuring we are open enough to incorporate missing parameters or special local characteristics as discovered or modelled. If we get this right, there is every possibility this tool will be a game-changer when it comes to discussing the impact of infrastructure changes on those who live near a train line."*

In situ noise recording, performed in Crespin, France (July 2021).

There are two other WPs in the stream (WP9 and WP10) that are also integral to success of the FINE-2. Both are highly collaborative, with WP9 liaising with TRANSIT and SILVARSTAR and WP10 working across the whole Shift2Rail organisation to understand how noise is being reduced by the programme's activities outside of FINE-2. Further information about these WPs can be found on the Shift2Rail website[3].

The project will conclude in early-2023, but results of our work are frequently published online, as well as presented at events. If you want more information about items detailed in this article, or would like the project to present at an event, please feel free to contact the Project Coordinator directly[4].

Standalone noise recording, performed in Charleroi, Belgium (July 2021).

REFERENCES

1. The TRANSIT project: Innovation towards train pass-by noise source characterisation and separation tools - *Global Railway Review, Volume 27, Issue 6 2021, pages 22-25*
2. SILVARSTAR project: Soil vibration and auralisation software tools for application in railways - *Global Railway Review, Volume 27, Issue 6 2021, pages 16-19*
3. https://shift2rail.org/
4. Scott.Heath@uk.thalesgroup.com

SILVARSTAR project: Soil vibration and auralisation software tools for application in railways

In this article for *Global Railway Review*, we discover how, in the work of the SILVARSTAR project, the development of auralisation and visualisation tools can be used to predict, and demonstrate, railway noise using virtual reality technology.

ALTHOUGH RAIL is a sustainable and climate-friendly mode of transport, noise and vibration remain particular environmental concerns. As urban congestion and demand for mass transportation increase, new railways are built closer to buildings, while development expands into the vicinity of existing railways. People living near railways are becoming increasingly sensitive and unable to tolerate noise and vibration, while the operation of sensitive equipment (e.g. electron microscopes, MRI scanners) is hampered by vibration transmitted into buildings.

Addressing these technical and socio-economic challenges requires the use of efficient and proven tools to quantify and assess the noise and vibration impacts of railway networks. In addition, the possibility to use auralisation and visualisation tools based on virtual reality (VR) technology opens up new opportunities to communicate the findings of noise studies. Such prediction and demonstration tools can help, for example, in determining where noise and vibration reduction should be prioritised, and in deciding on the most appropriate reduction measures depending on external constraints such as efficiency, cost and space.

To address these challenges, SILVARSTAR[1] – a two-year collaborative project under the Shift2Rail Joint Undertaking (JU) Programme – aims to provide the railway community with proven software tools and methodologies to assess the

noise and vibration environmental impact of railway traffic at a system level. The project brings together a unique consortium of six leading industrial, academic and association partners to contribute excellence in noise and vibration within the Cross-Cutting Activities of Shift2Rail.

The project partners are from five different European countries and have complementary knowledge areas and skills to promote the scientific outcome and to ensure the industrial uptake and delivery of tangible results in the field: Vibratec (France, Coordinator), Wölfel Engineering (Germany), Empa, Swiss Federal Laboratories for Materials Science and Technology (Switzerland), University of Southampton – Institute of Sound & Vibration Research (ISVR, United Kingdom), KU Leuven (Belgium) and UNIFE – European Rail Industry Association (Belgium).

Prediction of ground vibration through the development and validation of a hybrid approach

The first workstream (see *Figure 1*) focuses on the prediction of ground vibration through the development and validation of a hybrid approach, combining numerical prediction with experimental results. The computational model will be integrated into an existing tool and linked to a Geographical Information System (GIS), providing a Graphical User Interface (GUI) that allows vibration and noise impact studies to be performed. The basic concept

People living near railways are becoming increasingly sensitive and unable to tolerate noise and vibration

AUTHORS:

Pascal Bouvet
Project Coordinator, Vibratec

Geert Degrande
KU Leuven

David Thompson
ISRV, University of Southampton

Reto Pieren
Swiss Federal Laboratories for Materials Science and Technology (Empa)

Marta García
Union des Industries Ferroviaires Européennes (UNIFE)

is to develop a frequency-based hybrid vibration prediction tool that follows the general framework recommended in international standards that express the vibration level in a building during a train passage as the product of source, propagation and receiver terms. By combining experimental data with numerical predictions, this hybrid approach provides much more flexibility and applicability than purely experimental models.

This prototype prediction tool (TRL 5) will be fully integrated with the existing noise mapping software IMMI developed by Wölfel. The collaboration with ISVR, KU Leuven and Vibratec will result in a unique software platform that will allow engineers to perform noise and vibration environmental impact studies within the same integrated software environment. The proposed hybrid modular approach provides full modelling flexibility at each stage of the design process. Embedding in existing software will simplify the modelling process, as fewer interfaces are needed. Extensive validation and approval testing will increase confidence levels. It is intended that this novel software product will be upgraded to TRL 9 soon after completion of the SILVARSTAR project to find widespread application in railway engineering. The prediction tool will enable the assessment of vibration levels for both large-scale studies and more detailed studies by rolling stock manufacturers, track engineers, overhead railway owners and noise and vibration consultants.

Developing auralisation and VR software tools

In the second workstream, auralisation and virtual reality (VR) software tools are being developed based on a physics-based model to synthesise railway noise in high quality (see *Figure 2*). A novel audio-visual VR tool will enable a demonstration of railway noise including different mitigation measures.

The main contribution to the auralisation and VR of railway noise in SILVARSTAR is the further development of the latest scientific computational models to consider different mitigation measures. The SILVARSTAR auralisation models will be linked to commercial 3D visualisation software to realise immersive audio-visual VR experiences of railway scenes extending the applicability of the simulation beyond the state-of-the-art.

In this field, the main innovation of SILVARSTAR lies in the development of novel, ready-to-use auralisation and VR software tools and creation of a unique VR system to demonstrate railway noise. The new simulation tools will allow physically correct synthesis of railway pass-by noise and provide immersive audio-visual VR experiences

of future railway noise scenarios using a portable VR headset. As this allows users personally to experience, i.e. hear and see, realistic 3D scenes in a virtual environment, it is a modern and promising tool to communicate acoustic situations intuitively.

These novel tools will enable perception-based virtual testing of noise mitigation technologies and an effective demonstration of different noise scenarios, including noise mitigation measures and vehicle design variants. This will support decision-making and facilitate communication with stakeholders such as vehicle customers, engineers and designers through VR prior to project delivery. In order to communicate noise scenarios to local residents, policy-makers and the general public in the context of land use planning and infrastructure projects, the developed systems will support different display modes and interfaces to existing 3D visualisation software. Within SILVARSTAR, the new auralisation and VR software tools will be released as fully functional freeware applications. SILVARSTAR will thus take auralisation and VR of railway noise to the next level and provide new software tools to the industry.

Regulations

In relation with the regulatory framework, there are currently no harmonised European limits applied to vibration levels in buildings caused by transport systems; the same is true for re-radiated structure-borne noise inside buildings. Therefore, the SILVARSTAR project will focus on this aspect of exploitation for standardisation activities. This will mainly be accomplished through the individual links of members with standards and guidelines technical working groups (DIN 4150-2:1999, ISO/TC108/SC2/WG8, VASTCON TWG, CEN/CENELEC). The integration of the SILVARSTAR methodologies into standards will accelerate their acceptance in the railway engineering community and ensure the use of the associated tools.

FINE-2

SILVARSTAR works closely with the complementary Shift2Rail Members' project FINE-2[2]. FINE-2 is composed of three work streams that investigate means of enabling integrated mobility management, saving energy and reducing noise and vibration. SILVARSTAR is aligned with the vibration activities of FINE-2. In addition, the interaction with relevant stakeholders such as the steering committee of the Shift2Rail Cross-Cutting Activities (CCA), the EU Agency for Railways (ERA) and TC256/WG3 on Noise of the European Committee for Standardization (CEN) will ensure maximum visibility, impact and acceptance of the SILVARSTAR outcomes.

For further information please visit the project website[1].

FIGURE 1

FIRST WORKSTREAM OF SILVARSTAR OVERVIEW

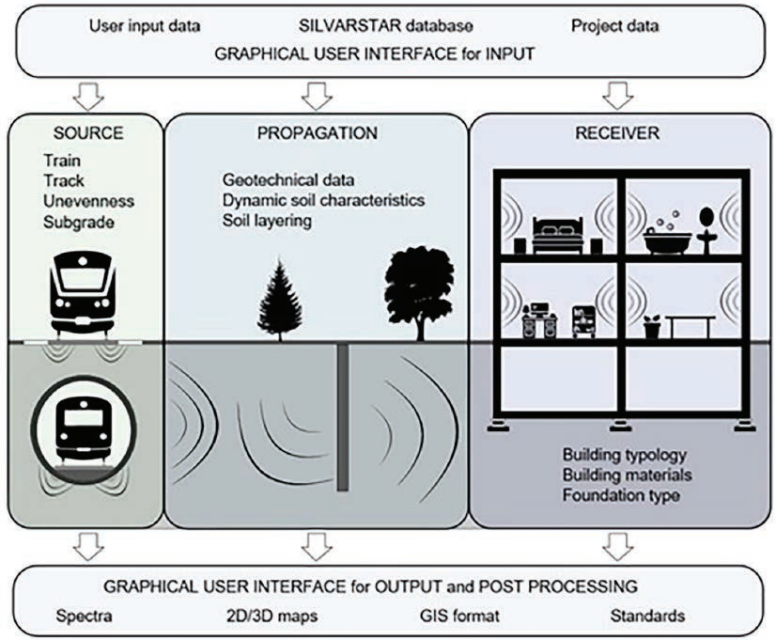
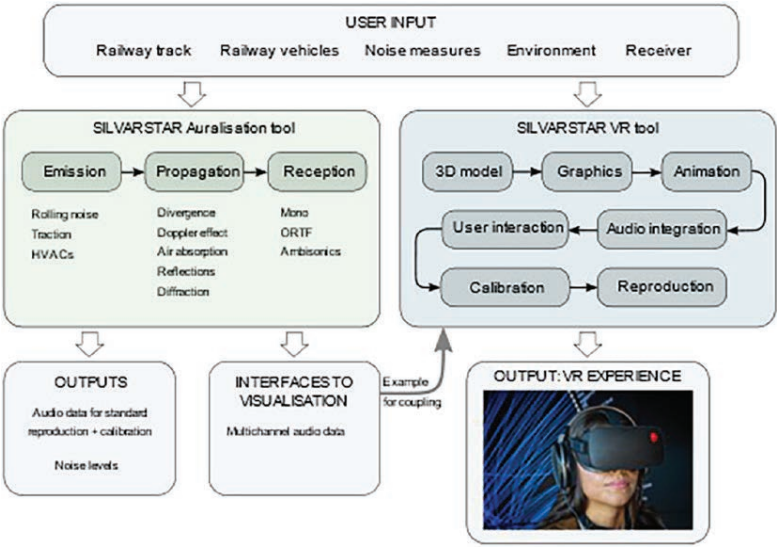


FIGURE 2

SECOND WORKSTREAM OF SILVARSTAR OVERVIEW



Horizon 2020 European Union Funding for Research & Innovation

Shift2Rail

The SILVARSTAR project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N 101015442. This document reflects only the authors' views and that the JU is not responsible for any use that may be made of the information it contains.

REFERENCES

1. www.silvarstar.eu
2. Noise and vibration work in the FINE-2 project - *Global Railway Review, Volume 27, Issue 6 2021, page 12-15*

Keeping an eye on everything with ZF's connect@rail solution

Reliability in rail transportation – be it cargo or people – is more important than ever. Operators and manufacturers must keep downtimes to a minimum, safety and comfort at a maximum, and avoid failures at all cost. Fortunately, ZF is able to support companies with its smart and digital connect@rail system for condition monitoring and maintenance management.

GRAZ, AUSTRIA'S second largest city, is quite a sight to behold. Its landscape is framed by the eastern Alps on one side and by the river Mur on the other side. Its inner city was declared a UNESCO World Heritage site. However, there was one thing disturbing this otherwise tranquil scene. The trams that run through the inner city had problems with flat spots – uneven wear – on their wheels. This not only posed a danger to the vehicles, but also led to audible rumbling and thumping. Both citizens and passengers complained about the noise. Graz Linien, the city's transport operator, first tried identifying the faulty vehicle wheels with stationary measuring equipment, but detection was spotty. At this point, ZF's connect@rail system came into play.

Smart. Thorough. Digital.

With connect@rail, ZF leverages its extensive expertise as a leading global company for driveline, chassis, and safety technology. The system is a comprehensive and modular approach to fleet maintenance management and condition monitoring, with the following features:

- Heavy Duty TAGs, battery-operated Bluetooth sensors that are placed on the vehicle bogies. There, they constantly measure acceleration, vibrations and other parameters
- Gateways, the VCU Onboard Units, with CAN interfaces, several analog input and digital output ports that supports Bluetooth, Wi-fi and all common GNSS. The gateway stores and pre-processes data gathered by the sensors
- The ZF IoT Cloud, accessed via said secure onboard gateway, that uses the collected data to detect damage early and precisely
- A dashboard for desktops and mobile devices that gives end-users a comprehensive overview of all parameters, reports, maintenance schedules and more
- Digital typeplates with an integrated RFID chip that log actual hours of service and mileage of individual components. They both facilitate and keep records of scheduled maintenance.

As connect@rail can be integrated and retrofitted into existing vehicle platforms and is not dependent on ZF-proprietary hardware, it offers manufacturers and fleet operators an efficient way to reduce downtimes. Thus, it helps keeping public and cargo transport running efficiently. By using connect@rail, Graz Linien was able to pinpoint the faulty wheels and even detected abnormalities that had gone unnoted before.

Tracking the track itself

In addition to its proven application in component monitoring, connect@rail can also use the gathered data to track the condition of infrastructure itself. Such is the scope of a recent cooperation between ZF and DB Systemtechnik, a subsidiary of German railway company Deutsche Bahn (DB). With an adapted version of its algorithm, connect@rail analyses the wear and tear on tracks and detects weak points early and precisely via GPS. ZF's Heavy Duty TAGs mentioned above act as sensors and are integrated into standard rail vehicles – which means that infrastructure monitoring is conducted during regular, everyday operations.

State of the art infrastructure and driveline monitoring

With connect@rail, ZF provides maintenance engineers and fleet operators with a modular and flexible solution to monitor the condition of driveline components and infrastructure. As an effective and economically efficient way to detect potential flaws at an early stage, the system allows operators to plan maintenance work predictively and flexibly. This in turn reduces unnecessary expenses, prevents delays and breakdowns, and offers real added value in terms of safety and comfort. Not only in Graz, but everywhere.

For more information, please visit: **zf.com/rail**

Your next connection: connect@rail

The intelligent condition monitoring system connect@rail demonstrates how integrated sensors and advanced data analysis tools can further improve efficiency, reliability and safety in rail transport.
www.zf.com/rail

For more information:
www.zf.com/rail

The TRANSIT project: Innovation towards train pass-by noise source characterisation and separation tools

Railway transport produces less CO_2 and consumes less energy than road and air transport modes; it also requires less space than road transport. However, noise and vibration (N&V) levels in the vicinity of railways are a major environmental challenge for the railway sector. In addition, a competitive railway transport system demands better passenger comfort. In this article, we discover how the TRANSIT project is responding to these very issues.

NOISE REDUCTION is addressed to some extent by the requirement of the Technical Specifications for Interoperability (TSI) for all new vehicles to meet noise limits in both pass-by and stationary conditions. Due to the high cost involved in such tests, and the need for a track section with specific properties, it is desirable to develop virtual testing and some progress has been made in a previous project (ACOUTRAIN) towards this.

In addition, advanced measurement methods are required that can identify the noise contributions of different sources on an operational train. The relative importance of the various sources on the vehicle as well as the track, needs to be better understood.

The overall goal of the TRANSIT[1] project is to provide the railway community with a proven set of innovative tools and methodologies to reduce the environmental impact and improve interior acoustic comfort of railway vehicles. Therefore, the main objectives of the TRANSIT project are:

- To reduce lead time and costs of rail vehicle noise certification, and lower track occupation requirement for testing by providing accurate virtual certification tools

- To reduce the need for a TSI-compliant track by developing and demonstrating accurate separation and transposition techniques
- To derive a more precise and better-founded definition of acoustic requirements for equipment suppliers, reducing time and cost
- To deliver improved source quantification for use in noise mapping and a more accurate assessment of noise abatement measures
- To enable lighter vehicles, thus lower energy consumption, while maintaining high levels of interior acoustic comfort.

A summary of the impacts and applications of the TRANSIT project is given in *Figure 1*.

The TRANSIT consortium brings together members with considerable experience in the railway sector. They bring leading-edge knowledge on topics ranging from best practice in the use of computer aided engineering tools for virtual prototyping and certification of products, to advanced measurement methods such as microphone array technologies for source separation.

Most of the activities in TRANSIT are focused on the experimental characterisation, modelling and separation of railway noise sources (at standstill and during pass-by) as well as the further development of the ACOUTRAIN external noise prediction tool to account for installation effects in the transmission paths. New test methods are also developed to quantify noise transmission paths from sources on rail vehicles to microphone positions beside the track accounting for installation effects.

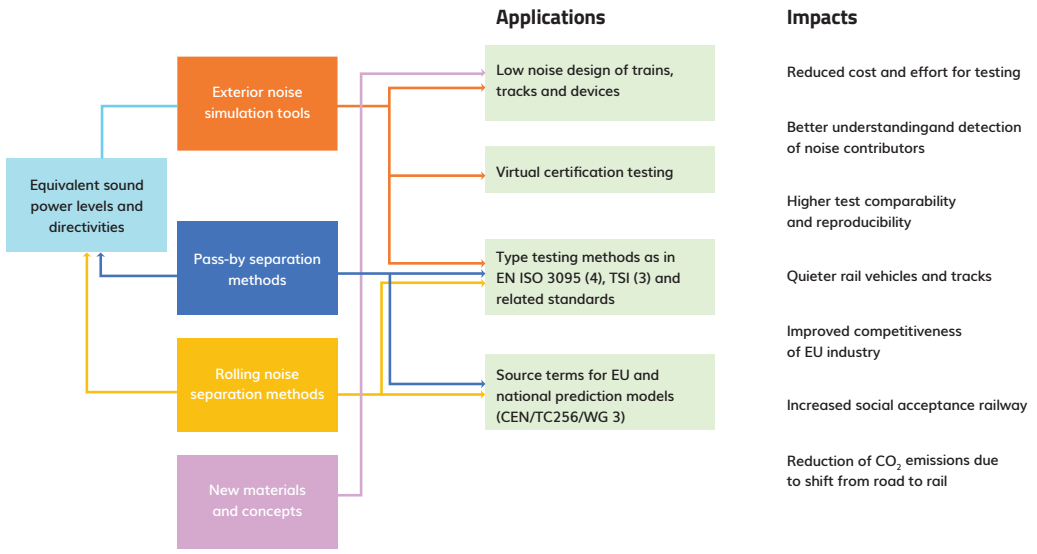
In addition, the project is also focused on the investigation on innovative materials and methods for an improved sound comfort. New and innovative approaches will be used to improve the design of the interior acoustics of future rolling stock. Several possible approaches are being considered, including optimal sound absorption at the source, damping along ducts for air conditioning systems and innovative meta-structure designs for the car-body parts.

Figure 2 represents the global approach of the TRANSIT project, in particular the translation of »

The overall goal of the TRANSIT project is to provide the railway community with a proven set of innovative tools and methodologies to reduce the environmental impact and improve interior acoustic comfort of railway vehicles.

FIGURE 1

SUMMARY OF TRANSIT APPLICATIONS AND IMPACTS



AUTHORS:

Inés López
Project Coordinator, Technische Universiteit Eindhoven (TUE)

Mats Åbom
KTH Royal Institute of Technology (KTH)

David Thompson
ISRV, University of Southampton

Ennes Sarradj
Technical University of Berlin (TUB)

Marta García
Union des Industries Ferroviaires Européennes (UNIFE)

Ester Cierco Molins
Ingeniería para el Control del Ruido (ICR)

Michael Dittrich
Netherlands Organization for Applied Scientific Research (TNO)

Martin Rissmann
Vibratec

Juan Moreno García-Loygorri,
Metro Madrid

the high-level objectives into technical objectives. It also shows the methodology implemented within the project.

The main expected impacts of TRANSIT arise from the methods and tools that will give a better understanding and quantification of the contribution of the different sources to the total pass-by noise. That will, in turn, lead to innovations in low noise design of vehicles and tracks, virtual certification testing, and the derivation of source terms for EU and national prediction models, among others.

The following four work streams are addressed, with specific technical achievements already reached:

1. Source and transmission characterisation for exterior noise

Source characterisation based on equivalent monopoles has been presented with a new simplified procedure assuming uncorrelated monopoles. The simplified procedure is based on sound power data determined via an ISO standard procedure, e.g. ISO 3744 or 9614. A calibrated monopole source is used to characterise the transmission and the simplified procedure has been validated for generic sources in the report (D1.1): "Validated procedure for source characterisation based on equivalent monopoles and tests involving generic sources". The ACOUTRAIN external noise prediction tool will be extended to account for installation effects in the transmission paths such as shielding. This will enable developments of virtual testing and homologation of new vehicles.

2. Pass-by noise source separation

The aim here is to obtain the sound power level and directivity of noise sources during pass by at constant speed of a train. The main sources considered are aerodynamic noise, traction noise, equipment noise and rolling noise. At least two different methods are investigated: one based on a microphone array and the other using a single microphone and rail-mounted accelerometer (PBA-based).

Pass-by noise source separation using a microphone array consists of measurement of train pass-by noise with a planar arrangement of microphones (at least 64 channels) and the use of acoustic imaging techniques for source separation (beamforming, advanced spatial filtering deconvolution, inverse methods).

3. Separation of track noise and vehicle noise

TRANSIT is working on the development of enhanced methods for separating vehicle and track contributions to rolling noise. The TSI Noise specifies noise limits for new vehicles which have to be measured on a track with a low contribution to the noise, specified in terms of track decay rate and rail roughness level.

Horizon 2020 European Union Funding for Research & Innovation

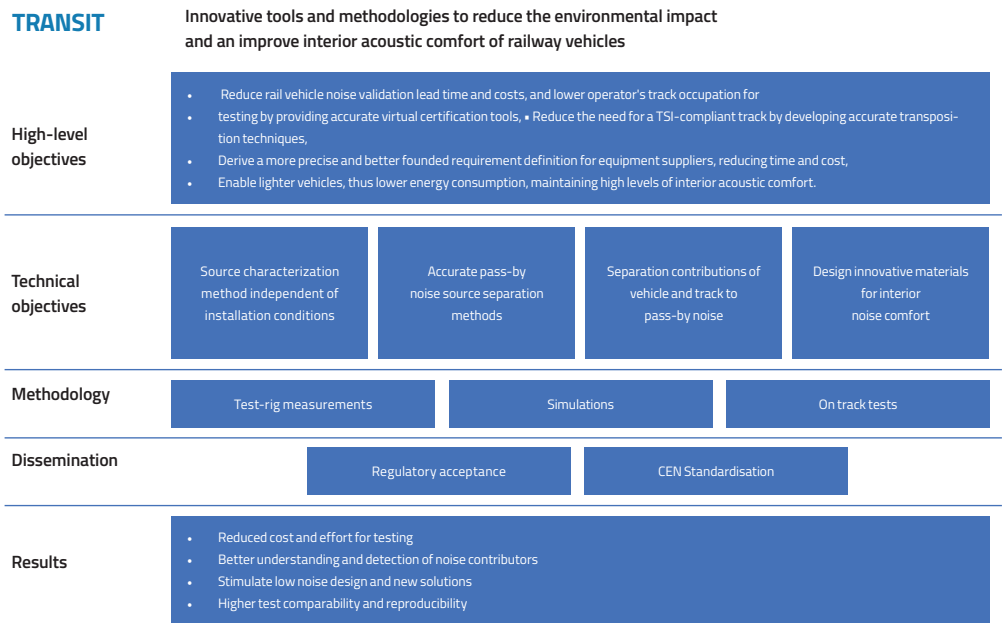
TRANSIT

Shift2Rail

The SILVARSTAR project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N 101015442. This document reflects only the authors' views and that the JU is not responsible for any use that may be made of the information it contains.

FIGURE 2

TRANSIT – FROM OBJECTIVES TO RESULTS



> *Based on the analyses and methods developed within TRANSIT, the project aims to enable future low noise railway vehicles with a reduced environmental impact and an improved interior acoustic comfort.*

Nevertheless, the track noise (and roughness) is still an important contributor to the overall level. This makes it difficult to compare results from different sites; moreover, further reductions in vehicle contribution may be masked by the track noise. It is therefore important to be able to separate the contributions of vehicle and track, to identify and promote low noise design. The proposed method should be applicable as an extension to the TSI Noise procedure.

4. Innovative designs in materials and methods for interior noise

Finally, TRANSIT is also working in exploring innovative approaches and material designs for an improved interior sound comfort. This started with a feasibility study for several potential solutions to proposed case-studies and is continuing with an in-depth analysis of the two most promising solutions. Innovative designs and methods are being studied, focusing on meta- structure designs and other tailored material design. Acoustic performance characterisation of baseline and new designs is carried out through simulation or small-scale measurements and acoustic performance of new designs will be validated in realistic conditions.

Summary of the main innovations in TRANSIT

The main challenge for current vehicle certification methods is the fact that the track is a significant contributor to pass-by noise whereas current techniques are unable to accurately separate vehicle and track contributions. TRANSIT is targeting this problem by developing methods to identify the contribution of vehicle sources and to separate the vehicle and track contributions to rolling noise.

Based on the analyses and methods developed within TRANSIT, the project aims to enable future low noise railway vehicles with a reduced environmental impact and an improved interior acoustic comfort. This is achieved by developing accurate and robust source characterisation and separation methods and techniques, and exterior noise simulation tools that will make virtual testing and more cost-effective vehicle certification and homologation methods possible. For interior noise control, innovative material designs to increase sound transmission loss and absorption will lead to an improved interior sound quality within the weight constraints.

The key to predicting overall noise levels accurately for stand-still or in the vicinity of the track during pass-by is an accurate separation and characterisation of the main contributing sources and this is the core of the research work in TRANSIT.

TRANSIT is firmly based on the results from past EU projects ACOUTRAIN and Roll2Rail and relies on the inputs from EU projects FINE-1 and FINE-2[2] to set the next steps towards virtual certification. Furthermore, a key aspect to maximise the visibility, impact and acceptance of the TRANSIT results is the interaction with relevant stakeholders such as the steering committee of the Shift2Rail Cross-Cutting Activities (CCA), the EU Agency for Railways (ERA) and TC256/WG3 of the European Committee for Standardization (CEN).

For further information about the project and partners, please, visit the project website[1].

REFERENCES

1. https://transit-prj.eu/
2. Noise and vibration work in the FINE-2 project - *Global Railway Review, Volume 27, Issue 6 2021, pages 12-15*