People still needed to shape railways

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Professor Vannes Gräbe, chair in railway engineering at the University of Pretoria in South Africa, delivered the 2019 lecture in railway engineering honouring the 40-year contribution of Dr Stephen Marich to the railway industry.

The lecture has been hosted every year by Monash Institute of Railway Technology (MIRT) in Melbourne since 2014.

The inaugural lecture five years ago was delivered by Dr Marich himself covering the principles behind wheel-rail interface, and the importance of management of the interface as well as the consequences when this is neglected.

In 2015 Harry Tournay, a senior scientist from the Association of American Railroads Transportation Technology Center, presented on ‘Strategies to Counter Wheel & Rail Rolling Contact Fatigue in Heavy Haul Service’.

Professor Elias Kassar from the Norwegian University of Science and Technology showed in 2016 how to ‘Improve Train Dynamics through turnouts by optimising track gauge and track stiffness’.

In 2017 Gary Wolf presented ‘New Inspection and Detection Technologies for Managing Track and Vehicles – Improving Asset Life and Reducing Deterioration’.

Dr Robert Fröhling from Transnet, South Africa, discussed ‘Vehicle-Track System Dynamics and Long Term Behaviour’ in 2018.

The year the lecture was focused on track infrastructure requirements and condition monitoring with an emphasis on advanced research, digital technologies and solutions. It covered examples of state-of-the-art digital technologies such as optical metrology, the Internet of Things (IoT), deep learning and augmented or virtual reality and explained how they have been used in condition monitoring of track infrastructure including bridges, track transitions, rail ballast and track formation.

Professor Gräbe addressed the audience of railway professionals on how railways across the world were experiencing a digital revolution that challenged traditional methods and the generic technologies.

In his presentation, ‘Track Infrastructure Requirements for the Digital Railway’, he said the integration of systems and processes had certainly offered greater capability from existing assets and increased the capacity, performance and connectivity of the railway system. Taking into account the fact that, over two centuries, conventional track infrastructure consisting of ballast, sleepers and steel rails had successfully retained its position as the preferred track structure for freight and most passenger railways, Professor Gräbe raised the important question of what track infrastructure requirements would be in the future.

Professor Gräbe addressed some of the important topics relevant to the digital railway:

- Smart infrastructure which incorporates sensors and integrated, digital communication networks as well as optical technologies to report on its current state and performance;
- New IoT devices that are now being developed at an exponential rate and can measure track parameters and set condition, from simple temperature measurements to high frequency accelerations in three dimensions;
- Big data in combination with machine learning models which enable engineers to replace reactive maintenance actions with condition-based and predictive maintenance interventions;
- Augmented and virtual reality which enables effective track inspection and simulations for training and incident investigations;
- Measurement of the movement of rail with nine degrees of freedom; and
- Investigation of ballast behaviour on a discrete, granular scale to understand ballast vibrations, forces experienced as well as ballast fabric and structure.

Professor Gräbe then talked about optical metrology and 3D scanning using white light LED with an accuracy of 25mm. He mentioned that various 3D scanning applications existed and included:

- Scanning of welds and rail sections to determine local profile geometry;
- Validation of ballast requirements in terms of shape and roughness, specifically; and
- 3D model of ballast particles and substructure components for discrete and finite element analysis.

Turning to the emergence of digital track scanning and photogrammetry, he said these technologies were gaining significant momentum and were contributing significantly to digital railways by allowing track infrastructure inspections, the creation of 3D infrastructure visualisations and the development of point cloud data for rail infrastructure asset management.

On the artificial intelligence (AI) and big data side, he stressed the AI boom and the flourish of machine learning. He used the example a process through which parameters of the permanent way and interacting systems were measured using utilising acoustic, magnetic, electromagnetics and optical devices. These measurements alongside theoretical frameworks and big data and deep learning approaches could help in implementing real-time guidance as well as remedial actions on track infrastructure. He then turned to condition monitoring, which he said was an excellent demonstration of track infrastructure requirements for the digital railway, and presented three examples of work he had carried out in South Africa:

- WIMA, or Weymouth Intelligent Long Stress (lateral rail stress) Management, which prevents blind rail distressing and provides continuous measurements linked to weather forecasting for derailment prevention and rail break detection;
- Bridge condition monitoring using IVDs, a weather station, temperature probes and strain gauges to predict bridge deck expansion and optimise the design of rail expansion joints; and
- Formation condition monitoring to study unainted soil behaviour and mechanise and real time monitoring of soil conditions.

 ― Track inspectors performing visual inspections cannot readily or easily detect certain track defects and we know the limitations of trolley inspections and walking inspections” Professor Gräbe said.

“Then there are also difficulties linking what inspectors see with available condition data. To manage these issues and to prevent effects from causing hold-ups, we need to use automated inspection systems.”

He then identified the solution: augmented and virtual reality systems with data source integration in which high-density, geospatial and visual components could be combined for an effective inspection. He also touched on another example of virtual reality simulation and showed a video used for incident investigation training.

Professor Gräbe concluded that creating value at new locations and in core businesses relied heavily on proactive decision-making, contextual interactivity, global connectivity, journey-focused innovation, technology, real-time automation and, finally, linking people, ideas and things. He suggested that perhaps we should balance the billions of dollars invested in technology by empowering people who would embrace technology, connectivity and automation.

At the start of the evening, Professor Rebekah Brown, Senior Vice-Professor and Vice-Professor (Research) and Program Director, Monash University, addressed the audience.

Professor Rebekah Brown delivers her presentation titled ‘Track Infrastructure Requirements for the Digital Railway’.

Professor Ravi Ravirhahan (left) and Dr Stephen Marich (right) present Professor Vannes Gräbe with a momento of his visit to Melbourne.

FROM FAR LEFT Monash University’s Institute of Railway Technology hosts the 2019 Stephen Marich Lecture in Melbourne. Professor Vannes Gräbe speaks on track infrastructure requirements and condition monitoring. Professor Rebekah Brown, Senior Vice-Professor and Vice-Professor (Research) and Program Director. Monash University, addresses the audience. Professor Vannes Gräbe delivers his presentation titled ‘Track Infrastructure Requirements for the Digital Railway’. IRT director Ravi Ravirhahan (left) and Dr Stephen Marich (right) present Professor Vannes Gräbe with a momento of his visit to Melbourne.

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