Toward Railway Innovation

Ascent

Railway Technical Research Institute

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WCRR 2019

WCRR 2019 and the Role of Railway Research

Mr. Ryuji Tsuchiya
Managing Editor
(Senior General Director, International Division)

I had the opportunity to work as the chairperson of the Executive Committee of the 12th World Congress on Railway Research (WCRR 2019), which was held in Tokyo from October 28th to November 1st, 2019. It really was a fascinating experience for me to be involved in the management of the world's largest congress dedicated to railway research.

This issue of *Ascent* magazine features WCRR 2019, which I believe, provided opportunities where railway delegates from around the world were able to share their views regarding the roles that research and development are expected to play in order to further elevate the value of railways.

WCRR 2019 covered a broad range of research fields including human factors, railway business management and transport economy. It also covered railway technologies regarding vehicles, track, power supply, signaling and communications, structures, train operation and environmental measures. It provided railway company executives and researchers and engineers from different fields the opportunity to share information. WCRR 2019 was organized into Plenary Sessions, Organized Sessions, an Exhibition and a variety of Social Events as well as Oral and Interactive Poster Sessions.

The Plenary Sessions took the form of panel discussions moderated by top executives from distinguished rail-related organizations around the world. Having an eye on the optimum form of future railway systems, each panelist gave their views on the direction that railway research and development is to take, technical fields to be focused on and desirable ways for international cooperation.

This issue of *Ascent* magazine includes the articles contributed by the moderators of three Plenary Sessions. They describe the outline of the discussion carried out in each session, highlighting the roles of railway research and development to enhance the customer experience and elevate the value of railways.

I sincerely hope you will find this issue of *Ascent* magazine interesting and helpful.

Ascent No.7 April 2020

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For Further Leap toward the Future of Railways

Dr. Norimichi Kumagai
President
Railway Technical Research Institute

I am grateful that so many people came to attend WCRR 2019 from all over the world and so many organizations at home and abroad supported this congress. Representing the host organization, the Railway Technical Research Institute, I would like to extend my sincere thanks here to every participant and supporting organization. As many as 939 people, including 424 from overseas, gathered in Tokyo to attend the congress and were able to share their experience, expertise and perspectives regarding railway research and technical development through truly lively exchange of ideas. I am so pleased that WCRR 2019 was able to provide such opportunities.

What role should railways play in the coming years? In what way can railway research contribute? I am sure that the significance of WCRR lies in the very effort to explore the answers to these questions by gathering the wisdom of rail-related people of all over the world. At the Plenary Sessions of WCRR 2019, the panelists representing the positions of railway operators, suppliers and research institutes had in-depth discussions on the role of railway research in creating the railways of the future, with an eye on the congress theme "Railway Research to Enhance the Customer Experience".

I believe that the role of railways is to become important part of social mobility through gaining trust from customers by further enhancing the safety and providing universal, pleasant services. In addition, railways have to be sustainable from the viewpoint of environmental conservation as well as of business management so as to keep playing a significant role as part of social infrastructure. Railways have been considered to have an advantage over other transport modes in terms of environmental footprint. In recent years, however, the environmental performance of other modes including automobiles has been rapidly improved and our efforts to raise the advantage of railways are even more important. As this is also the case with other advantages of railways such as safety, high-speed and punctuality, we need to aim higher.

We are facing so many challenges. Among them, most urgent tasks are streamlining of railway operation with digital technologies, improving competitiveness by making railways more attractive and addressing the issues of climate change and extreme weather disasters.

I am confident that WCRR 2019 was able to provide a good opportunity for rail-related people to share the recognition of these important issues, their expertise and experience and to trigger their joint commitment to create a better future of the railways. I do hope to take a further stride towards the future of the railways, together with you all.

Looking Back on WCRR 2019

Dr. Ikuo Watanabe
Chairperson of the WCRR 2019 Organizing Committee
(Executive Vice President of RTRI)

At WCRR 2019, which was held in Tokyo from October 28 to November 1, 2019, I feel that very productive discussions took place and many participants were able to share their expertise. At this congress, three Plenary Sessions featured panel discussions by executives of railway-related organizations around the world, addressing the congress theme of "Railway Research to Enhance the Customer Experience." The panelists representing the positions of railway operators, railway suppliers, and railway research institutes provided important perspectives concerning the direction in which the railway industry should proceed and what we should do to create the railways of the future, and we were able to share these views with many railway-related participants from around the world.

This congress was the first time WCRR held Organized Sessions that were organized and chaired by invited experts of various fields with the aim of encouraging active and in-depth discussions on research themes that are attracting worldwide attention. Since it was the very first attempt to include sessions of this format in the WCRR program, we were not completely confident at first about whether these sessions would be successfully run. However, thanks to the chairpersons who organized them, the Organized Sessions were able to provide opportunities for truly lively exchange of ideas. In particular, the sessions on autonomous trains and on-board monitoring had so many participants that I was able to confirm that these fields are focal points of current railway research. In addition, the congress set up sessions on cross-cutting topics such as horizon scanning, innovation process, and global certification; I believe we were able to have a closer look at the issues that the railway sector should address and from a different perspective than in the conventional vertically divided sessions on respective technical fields. I am very grateful to the chairpersons for their contribution to running these sessions and to the members of WCRR Organizing and Executive Committees for recommending such outstanding session-organizing chairpersons.

My overall impression of the congress is that the railway sector already shares the perception that digitalization is an inevitable issue for railways; now, we are in the phase where we should concretely examine how to implement and develop digitalization in the actual daily operation of the railways. The main theme of this congress was determined through intense discussions at the WCRR Organizing and Executive Committee meetings. Many ideas have come and gone and the word "digitalization" was among the keywords discussed. As the word "digital" has broad implications and some doubts were raised regarding the validity of highlighting only "digitalization" in the wide-ranging scope of railway research, a decision was made not to include this word in the congress theme. Nevertheless, this congress resulted in a good opportunity to demonstrate the significance and tremendous impact of digitalization to the railways.

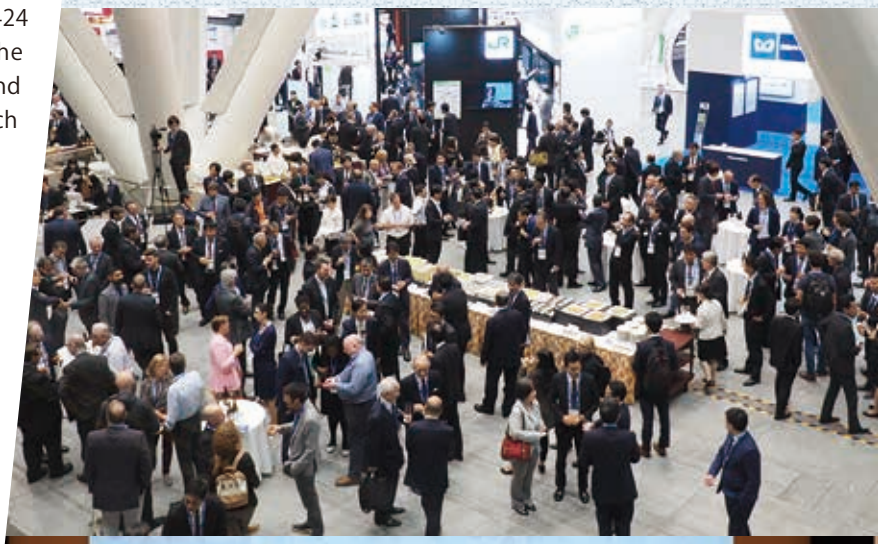
Finally, I would like to express my gratitude for the great support of our congress by our generous sponsors, exhibitors, and everyone who came to attend this congress from all over the world.

WCRR 2019 — Toward Enhanced Customer Experience

993 railway professionals gathered in Tokyo

The 12th World Congress on Railway Research, WCRR 2019 was held from October 28 to November 1, 2019 at the Tokyo International Forum under the theme "Railway Research to Enhance the Customer Experience." WCRR is an international congress organized by the WCRR Organizing Committee composed of Union Internationale des Chemins de fer (UIC), Société Nationale des Chemins de fer Français (SNCF), Deutsche Bahn AG (DB AG), Trenitalia, Rail Safety and Standards Board (RSSB), Transportation Technology Center, Inc. (TTCI) and Railway Technical Research Institute (RTRI). A total of 993 people, 424 from 37 countries and 569 from Japan, participated in the congress. Three Plenary Sessions, 10 Organized Sessions, and 60 oral and interactive poster sessions covering eight research fields were provided. A total of 353 papers were presented.

Dr. Tetsuo Uzuka
General Director
International Division
Former General Secretariat of WCRR 2019



Dr. Ikuo Watanabe
Chairperson of the WCRR 2019 Organizing Committee
(Executive Vice President of RTRI)

Opening Ceremony welcomed delegates from around the world

The Opening ceremony of WCRR 2019 started with remarks by Dr. Ikuo Watanabe, Chairperson of WCRR Organizing Committee and Executive Vice President of RTRI, followed by the welcome speech by Dr. Norimichi Kumagai, President of RTRI, who mentioned his hope that the congress would trigger the move to build a better future for railways. Mr. Nobuhide Minorikawa, State Minister of Land, Infrastructure, Transport and Tourism, Mr. Takashi Nakajima, Director, Bureau of Urban Development, Tokyo Metropolitan Government and Prof. Gianluigi Castelli, Chairman of UIC, Chairman of Ferrovie dello Stato Italiane (FS) Group made congratulatory speeches.

Plenary Sessions highlighted innovation enablers and key research areas

Three Plenary Sessions were organized with top executives of railway operators, rail-related manufactures and research organizations. These Plenary Sessions were conducted to identify innovation enablers and key research areas where we should be targeting in order to elevate the value of railways. Plenary Session 1, which was moderated by Prof. Anson Jack, University of Birmingham, UK, had the theme "The role of Railway Operators in Enhancing the Customer Experience." Plenary

From top to bottom

Mr. Nobuhide Minorikawa
State Minister of Land, Infrastructure, Transport and Tourism

Dr. Norimichi Kumagai
President of RTRI

Mr. Takashi Nakajima
Director, Tokyo Metropolitan Government

Prof. Gianluigi Castelli
Chairman of UI, Chairman of Ferrovie dello Stato Italiane (FS) Group

Session 2, which was moderated by Mr. Nick Kingsley, Managing Editor, Railway Gazette International, had the theme "Contribution of Railway Suppliers to Elevating the Value of Railways." Plenary Session 3, which was moderated by Prof. Roderick Smith, Future Railway Research Centre, Imperial College London, UK, had the theme "Research and Development for Future Railways." The details of these Plenary Sessions are described in the articles contributed by each moderator that appear in this issue of Ascent magazine.

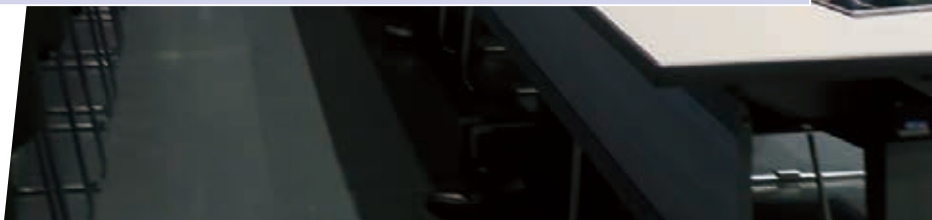
10 Specially prepared Organized Sessions, moderated by world's leading experts, invoked active and in-depth discussion

The Organized Sessions were included in the congress program for the first time. They were intended to encourage in-depth discussions on the world's hottest topics and were characterized by unified topics and flexible styles of presentation. Forty-four presentations (ten from Japan) were made at the Organized Sessions under the leadership of the chairpersons who are outstanding experts in each field.

As is depicted in Table 1, six out of ten Organized Sessions were concerned with cutting-edge technologies attracting high attention from the railway community. The other four Sessions were related to more general, cross-cutting themes.

Table 1: List of Organized Sessions

Organized Sessions for Cutting-Edge Technologies	Decision-Aid for Real-Time Railway Operation Control
	Autonomous Trains on Main Lines
	Digital Technologies for Predictive Maintenance
	On-Board Monitoring for Vehicle/Infrastructure Diagnostics and CBM
	Integration of On-Board and Wayside Measurements with Virtual Methods Towards Safer, More Cost-Effective, Risk-Conscious and Innovation Spurring Assessment Methods for Running-Dynamics
	Maglev Systems
Organized Sessions for Cross-cutting Themes	Horizon Scanning for the Railways: An International Collaboration Perspective
	Global Certification for Innovative Product Development
	Global Vision for Railway Development
	From Research to Benefits: How to Accelerate the Innovation Process

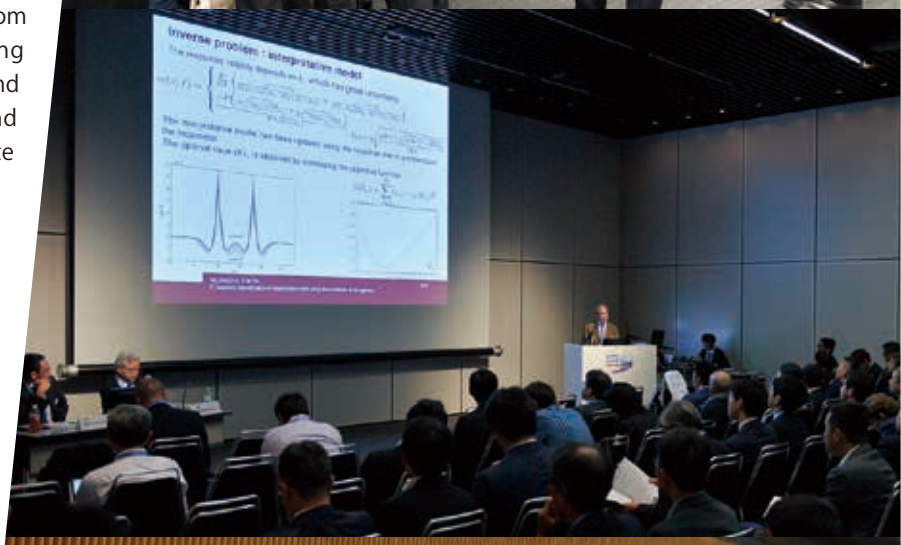


Oral Sessions/Interactive Poster Sessions covered 8 main categories of railway research

At the oral and interactive poster sessions, 167 oral presentations (44 from Japan) and 142 (59 from Japan) interactive poster presentations were made in the following eight categories:

- Improvement of Service Quality, Speed, Time to Destination, and Functionality
- Economics, Policy and Planning
- Sustainability
- Safety and Natural Hazard Management
- Rolling Stock
- Infrastructure
- Railway System Interface
- Maglev and New Transport Systems

It is worthy of special mention that we had as many as six sessions, two Organized Sessions and more than 50 papers regarding condition-based maintenance (CBM), which is one of the essential technologies for digitalized maintenance. Sessions on the application of digital technologies to railway operations, including autonomous trains, attracted much attention from the audience, reflecting the rail community's increasing interest in these areas. I believe it is time for us to apply and develop digital technologies to actual rail operations, and that we are already in the phase of working out a concrete methodology.



Exhibition and Social Events provided networking opportunities for railway professionals

In addition to presentations in the sessions mentioned above, we provided delegates with opportunities for exchanging their ideas and experiences in a more informal and relaxing atmosphere. These opportunities included the technical exhibition, which took place in the same Congress venue, and a variety of social events.

The exhibition provided opportunities for rail-related organizations in Japan and overseas to present their research works and latest technologies to the congress delegates. Major exhibitors were the JR group (represented by RTRI), JR East, Shift2Rail Joint Undertaking, China Academy of Railway Science, RSSB, and the University of Birmingham.

The Welcome Reception, which was the first formal gathering of this congress, was held on the first day

of the congress and the participants enjoyed the ideal networking opportunity as well as visiting each exhibition booth. The Tokyo Bay Reception was held on the second day and provided opportunity for the participants to mingle with each other and enjoy a light meal and drinks on a cruise boat.

The Gala Dinner was held on the third day of the congress as the official congress banquet at TOKYO KAIKAN (reopened in January 2019 after refurbishment), which has been serving as an authentic venue of social exchange in Tokyo since 1922. About 800 people attended the Gala Dinner, where Prof. Eisuke Masada, Chairman of RTRI, Mr. Kazuyoshi Akaba, Minister of the Land, Infrastructure, Transport and Tourism and Mr. Yuji Fukasawa, President and CEO of East Japan Railway Company gave welcome greetings.

Delegates experienced state-of-the-art Japanese railway technologies through 11 Technical Visits

Delegates chose from 11 Technical Visits to railway related facilities and construction sites that were provided. Thanks to the cooperation by JR companies, Japan Railway Construction, Transport and Technology Agency, Tokyo Metro and other railway-related companies, these visits gave participants good opportunities to see the technologies that support the high level of safety, efficiency, convenience and environmental performance of Japanese railways. They included two tours of RTRI's facilities: one to the RTRI and Railway Information Systems Co., Ltd. in Kunitachi, and the other to RTRI's Wind Tunnel Technical Center in Maibara and the Kyoto Railway Museum. These tours were joined by 53 and 26 delegates respectively.

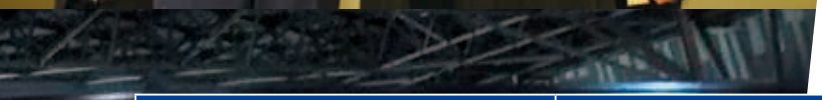
From top to bottom

Mr. Kazuyoshi Akaba
Minister of Land, Infrastructure, Transport and Tourism

Mr. Yuji Fukasawa
President and CEO of East Japan Railway Company

Prof. Eisuke Masada
Chairman of RTRI

Kagami-Biraki (Breaking open a ceremonial sake barrel)

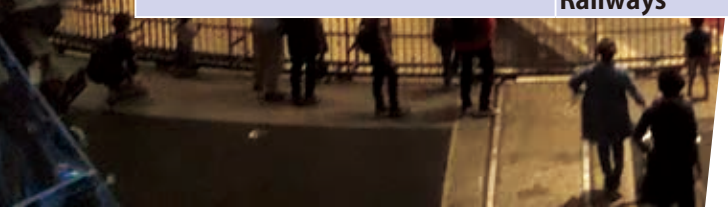


Congress summary and announcement of the WCRR 2022 were presented at Closing Ceremony

At the Closing Ceremony, WCRR 2019 Organizing Committee Chairperson, Executive Vice President Watanabe of RTRI summarized the events of the Congress and mentioned some key points discussed during the sessions. He highlighted the importance of digital technologies in improving railway operations and maintenance processes. Following Dr. Watanabe's concluding remarks, awards were given to the best paper in each field and the young researcher. Ms. Luisa Moisio, Program Director of RSSB and Prof. Anson Jack, University of Birmingham announced that the next WCRR will be held in Birmingham, UK in 2022. Dr. Watanabe handed over the WCRR plaque to Ms. Moisio and Professor Jack.

Best paper award winners

Category	Title	Presenter
Improvement of Service Quality, Speed, Time to Destination, and Functionality	**Maximization of passengers' punctuality by real-time junction rescheduling**	**François RAMOND, SNCF, France**
Economics, Policy and Planning	**The Hungarian railway reform process and the implementation of periodic timetable (Taktfahrplan)**	**Balázs ÁCS, University of Szeged, Hungary**
Sustainability	**Towards a sustainable railway infrastructure**	**Matthias LANDGRAF, Graz University of Technology, Austria**
Safety and Natural Hazard Management	**Taking a Human Factors Approach to Safety Critical Training: A Case Study**	**Ann MILLS, RSSB, UK**
Rolling Stock, Maglev and New Transport Systems	**Development of rolling stock under floor visual inspection system by image processing technique**	**Hiroyuki NAKAJIMA, Tokyo Metro, Japan**
Infrastructure	**System for Preventing Flaking of Lining Concrete in Subway Tunnel Using Four Methods**	**Hirotake NOGUCHI, East Japan Railway Company, Japan**
Railway System Interface	**Development of a High-Speed Adjustable Perturbation Slab Track**	**Dingqing LI, TTCI, USA**
Condition-based maintenance, condition monitoring, inspection and detection, including data and predictive analytics	**Wearing models for pantograph stripes condition-based maintenance**	**Alfredo BIANCUCCI, Trenitalia, Italy**
Young Researcher	**Adaptable Communication System for all Railways**	**Ulrich GEIER, Kapsch CarrierCom Deutschland, Germany**



Plenary Session 1
The Role of Railway Operators in Enhancing the Customer Experience

From Today's Research to Tomorrow's Enhanced Customer Experience

Moderator: Prof. Anson Jack
University of Birmingham, UK

It was my great honour to moderate the first Plenary Session of the 12th World Congress. What better way to start proceedings than to have the leaders of some of the most important railway companies in the world share with us the varied benefits that have been delivered for their customers through research, and to set the challenges for future researchers to address.

We had the President of the North American Transport Technology Centre Inc (TTCI), Lisa Stabler, the Vice Chairman of the East Japan Railway Company, Masaki Ogata, the Deputy Chief Executive and Chief Technical Officer of SNCF from France, Pierre Izard, the Executive Vice President and Representative Director of the Central Japan Railway Company, Shunichi Kosuge, the Chief Technical Officers from Germany, Rolf Härdi, of DB, and Italy, Marco Caposciutti of Trenitalia.

The panel session was organised in two parts. Each panellist was asked to introduce their company and the achievements they are proudest of which have been delivered through research. This was followed by each of the distinguished speakers describing the biggest challenges they face, where they are looking to the research community to deliver solutions in the future.

Pierre Izard kicked things off by describing the size and scope of SNCF' s activity, pointing out that SNCF led the introduction of High Speed Rail in Europe, with extensive research support for all of the technologies needed to make HSR the success it has been. He drew attention to SNCF's diversification, with one third of its total revenue coming from overseas activities. Three more recent developments he highlighted are the personal mobility assistant, the digital freight train and digital brake tests.

Masaki Ogata followed by describing the immense scope of the East Japan Railway Company Activity – moving 17.9 million passengers per day, principally in and around Tokyo, but also the many Shinkansen routes to the North, and the development of retail and other property assets. The vision of JRE is to provide the smoothest of journeys for passengers and he characterised this in three dimensions; horizontal - through seamless operations and good connections, Vertical – through efficient escalators, lifts and platform screen doors and Psychologically – through Smart Cards and Mobile Phone applications. The theme that holds this all together is that of MaaS – Mobility as a Service, and Ogata san shared some of the initiatives that had been promoted for MaaS when he was the president of UITP.

Masaki Ogata
JR East, Japan

Shunichi Kosuge
JR Central, Japan

Pierre Izard
SNCF, France

Rolf Härdi
DB, Germany

Marco Caposciutti
Trenitalia, Italy

Lisa Stabler
TTCI, USA

Rolf Härdi explained that DB and its subsidiaries carry 4.5 million people per day and 200 million tonnes a freight a year, making it the largest railway operator in Europe. Like JRE, DB are moving rapidly into Mobility as a service, and he described the various steps, arising from research and development activity, that have helped to deliver enhanced levels of passenger comfort and convenience. These include a travel app that provides all the information a traveller could want; the novel development of highly accurate and clear sound for station announcements, based on much smaller and targeted speaker systems. Other innovations that have been derived from research include the use of lighting within concrete on platforms to assist passengers in wayfinding, the increased use of vegetation within station designs, to enhance carbon capture and improve the environment; the development of smart lockers for bikes; and a facility to accept and segregate all types of waste through one portal.

Shunichi Kosuge explained how the Tokaido Shinkansen is the backbone of the Central Japan Railway Company and also the key travel corridor for two thirds of the population and economy of Japan. Being the first Shinkansen in the world, it was and is the product of research into all the various systems that enable efficient movement at ever higher speeds. He showed how the research effort on HSR has enabled todays trains to be 25% lighter while travelling 65 kph faster, while consuming less electricity than the earlier versions of Shinkansen, making the service more and more sustainable. All of this having been achieved while having Zero fatalities over the 55 years of operation, emphasising how safety is the number one priority.

Marco Caposciutti told delegates that Trenitalia moves around 250 million train kms a year, of which 60 million are High Speed. He also pointed out that Italy is the only country in the world where there is on rail competition among high speed operators, which is a driver for innovation and value for money. While emphasising how the top priority is for ever improved safety, he highlighted innovations through the new dynamic maintenance management system which will help to improve performance and reduce cost; about the improvement in delivering internet on board trains and the development of the new train for Trenitalia's regional services.

Lisa Stabler runs the USA's world leading research facility at Pueblo Colorado, and emphasised the difference between the North American Railways, which are dominated by freight, and the passenger-oriented activities of the other panellist's railways. She emphasised that freight customers want three things from their railroads – On time delivery, goods in top condition and delivered for the lowest possible cost. She went on to explain how the research and development of wayside detection equipment has led to a 40% reduction of notifiable derailments, albeit, in the last few years the rate of improvement had slowed – leading to the challenge she was to set later in the panel.

In following up the introductory remarks, Pierre Izard highlighted a number of further research based developments – the challenge to assure safety when using artificial intelligence, sharing intelligence between the train and the track, whether there is a role for quantum computing in railways, the development of intelligent level crossings and the critical challenge of cyber security for the railways. Building on these challenges Marco Caposciutti highlighted that while many operators, including Trenitalia, are seeking to raise speeds above 300 kph to further reduce journey times, there are issues like flying ballast that need to be solved to do so safety. Shunichi Kosuge reflected on the

PI SNCF — ***We are really convinced at SNCF that the railway system must be the backbone of mobility for the 21st Century.***

MO JR East — ***The public transport will lead MaaS and JR East will build up MaaS, Mobility as a Service, as a platformer for the life of people.***

SK JR Central — ***The Linear Chuo Shinkansen will dramatically expand the range of people's activities, create a completely different business and lifestyle, and have new economic benefits.***

RH DB — ***It's not good enough anymore to move from one station to another. DB have to cater for the entire service.***

MC Trenitalia — ***Trenitalia wants to reduce journey time and increase the customer experience of our customers.***

LS TTCI — ***Customer satisfaction for freight has three areas. It is on time, without any damage, and lowest cost possible.***

development of the Chuo Shinkansen, using superconducting maglev technology, which will provide an alternative and faster route from Tokyo to Nagoya and ultimately to Osaka, providing Japan with a more assured route (against geophysical risks) as well as further technological leadership of world railways. He also commented on the alternative high speed development from America, the Hyperloop, and suggested that there are two significant issues which may hamper its widespread introduction – first the safety issues around assuring a continuous vacuum, the loss of which would be catastrophic for passengers, and secondly, the fact that it could never match the capacity of conventional or maglev trains, thus limiting its commercial potential.

Future Challenges

The challenges that our panellists offered for future researchers were many and varied, and, with one exception, I will describe them without mentioning the author as these are all universal challenges which researchers are invited to address over the coming years.

The wheel rail interface is the fundamental technology that gives railways their competitive advantage, and there remain challenges to address over the forces and materials arising at the tiny contact point – future research into the profiles and material used could lead to reductions in rail and wheel fatigue which would improve safety, cost and passenger/freight comfort.

Global warming, and the role that railways can play in meeting carbon targets was a common theme. The development of optimised wheel rail interface, the development of hybrid, battery and hydrogen powered trains and further work on weight reduction will all help railways to maintain and improve its lead in environmentally sustainable transport. This theme leads to the one attributable quote I am going to mention. Guillaume Pepy, the retiring President of SNCF was due to participate in the panel but had to return to Paris at short notice for family reasons. Before leaving Tokyo he insisted that the panel discussion should include his commitment that railways should develop as the backbone of sustainable mobility in the 21st century and Pierre Izard was eloquent in passing this message on.

The challenges of digitalisation, which offers both huge potential in the exploitation of artificial intelligence and machine learning while creating risks in the form of cyber security and the increasing complexity of the 'production line' were mentioned by all of the panel.

On service and comfort, the sector must improve its product offering to compete with new models of car design, ownership and operation to ensure that rail does become the backbone of MaaS. Many of the panellists developed the MaaS theme, with co-operation with other linked modes, shortening total travel time (STT), data integration exploitation, and excellence in customer information, all areas where researchers can develop solutions.

The panel had focussed quite a lot on technology and environment, but all supported the overarching importance of researching futures that address people issues – such as the demographic time bomb of declining populations and the skills and cultural challenges that staff will face as the industry transforms itself into a digitally driven sector. Where populations are likely to reduce this enhances the need for ever more efficient use of labour and even the development of autonomous trains, which have potential for freight, metro and mainline passenger services.

After a stimulating and thought provoking 75 minutes, the Plenary Session was brought to an end with thanks from the audience for the panel's many insights, which really had helped us all to see a prospectus for future research and to anticipate some of the exciting opportunities that can form the basis of papers for the 13th WCRR in 2022 in the UK!

Plenary Session 2
Contribution of Railway Suppliers to Elevating the Value of Railways

Skills Agenda Key to Supply Chain Success

Moderator: Nick Kingsley
Managing Editor
Railway Gazette International

The second Plenary Session at the 2019 World Congress on Railway Research focused on the role the supply industry could play in ensuring development of a customer-focused global railway sector.

Organised by Japan's Railway Technical Research Institute as part of the 2019 edition of WCRR, the second Plenary Session of the congress brought together a globally diverse representation of the rail supply sector. Represented were two of the largest players in global rolling stock production, CRRC and Siemens Mobility, along with the multidisciplinary Hitachi Rail – the former Ansaldo businesses – and Amsted Rail, representing the North American private railroad sector. The domestic Japanese supply industry was represented by J-TREC.

The panel was brought together primarily to address six core questions over the course of just over an hour. These were:

- The cost of railway investment
- Whole-life maintenance of railway assets
- Commercialising research-driven rail innovation
- Small businesses in the rail supply chain
- Consolidation and competition among suppliers
- Mitigating the skills crisis

The first of these topics focused on the need for the supply industry to produce commercially viable products at an effective price, in recognition of the fact that – with the exception of North America – most global rail spending is at least partly dependent on the provision of public funding. Takao Nishiyama, Executive Vice-President of J-TREC, suggested that in the Japanese market at least, it was difficult to have truly low-cost rail vehicle production because all orders were essentially 'made to measure', in stark contrast to the heavily modular approach to modern automotive production for example.

Ding Sansan, Vice Chief Engineer at CRRC Qingdao Sifang, argued that the upfront

Jay Monaco
Amsted Rail, USA

Jürgen Schlaht
Siemens, Germany

Takao Nishiyama
J-TREC, Japan

Maurizio Manfellotto
Hitachi Rail, Italy

Ding Sansan
CRRC, China

cost of railway equipment was only a narrow means by which to understand the importance of railway investment. Instead, he suggested that the role of the supply industry should be seen in the wider context of the role railways play in the social and economic development of the country, pointing to China's vast investment in high speed rail over the past two decades as an example. 'We cannot just think of short term benefits of one engineering project', he added.

Turning to the question of the rise of whole life cost analysis in understanding the true cost of a product, Jay Monaco, Vice President of Global Engineering at Amsted Rail, felt that developing true life-cycle cost-based procurement was 'difficult to achieve', because 'there are still competing budgets, competing departments that are looking to meet different objectives, even if they are in the same company. It's even more difficult, which we face in North America, when we have operators, owners and lessors or shippers that are different from railcar manufacturers yet, who have yet another objective, to reduce the cost, try to win the contracts.'

Nishiyama meanwhile cited the E235 trainsets produced by J-TREC for its parent railway JR East to highlight how real world operating experience could be used to feed into the design process for rolling stock, driving enhanced maintenance procedures, faster cleaning and reduced energy consumption.

From research to real-world operations

Asked how the supply industry could help get academic research ideas adopted commercially, Maurizio Manfellotto, Chief Executive of Hitachi Rail Italy, felt that 'true co-production with the customer' would be key. This applies to new technology both in rolling stock and infrastructure; he cited the example of a partnership with the technical university in Milano and state railway group FS which led to the development of the ETR400 Frecciarossa high speed trains, which were jointly supplied by Hitachi and Bombardier Transportation. 'We will now work with our main customer, Trenitalia, to look at how we work to develop the next generation of regional trains as well as the potential for hybrid traction.'

One potential challenge facing the supply chain is the management of the relationship between small businesses, the

start-up community and the large system integrators. Jürgen Schlaht, Vice President for Innovation Management at Siemens Mobility, noted that his company 'did not produce its own subcomponents', which means co-operation with smaller players was fundamental. He also praised the work being down under the European Union-backed Shift2Rail innovation programme, of which Siemens is a founder member. 'There is no doubt Shift2Rail has been a success so far, but it has only been working for three years', and he felt that a much longer period of return on investment was inevitable in rail. 'It takes maybe 12 to 15 years to get benefits of pure research seen on the tracks', Schlaht said.

The panel was asked if the recent global trend towards consolidation in the supply chain, typified by large merger deals, would help lead to a more customer-focused railway, or could it be a hindrance to innovation? Ding Sansan pointed out that within the vast CRRC group, each subsidiary company was highly competitive, with a high degree of corporate independence. This means that, in his view, the focus on innovation and customer service can be upheld, 'ensuring we have a balance between competition and co-operation across the group.'

'A certain amount of consolidation is not necessarily a negative thing', felt Monaco, especially if standards and interoperability is maintained across the industry. 'A lot of times in the past, people have sort of shied away from research and development activities, because there wasn't a payback. That is what happens when you have too many suppliers in a given segment, it can actually cause harm to the industry.'

According to Schlaht, the Shift2Rail programme 'has helped deliver co-operation between directly competitive companies' where innovation takes place 'collectively, up to a certain point.' However, he recognised that it was 'not easy' to meet all the requirements of the European Union to join Shift2Rail.

Combatting the skills shortage

Manfellotto reflected on his company's experience where the former Ansaldo STS and AnsaldoBreda businesses were acquired over the past couple of years by Hitachi. 'The main issue is not the name, but the people', he believed, adding that 'we need to deliver more trains and

JM Amsted Rail: *Embrace technology and the changing nature of the rail industry so that suppliers can attract and retain the next generation of people.*

JS Siemens: *It is no longer a business which is all about heavy steel and concrete – it is as much about artificial intelligence and innovation in software.*

TN J-TREC: *Real world operating experience could be used to feed into the design process for rolling stock, driving enhanced maintenance procedures, faster cleaning and reduced energy consumption.*

MM Hitachi Rail: *We must have the new generation of staff with much greater understanding of digital technology – we must embrace Industry 4.0.*

DS CRRC: *The role of the supply industry should be seen in the wider context of the role railways play in the social and economic development of the country.*

technology in a shorter time, and we must get products approved faster.' This in turn puts pressure on the pool of engineers and other skilled staff available to suppliers, he felt. 'In addition, we must have the new generation of staff with much greater understanding of digital technology – we must embrace Industry 4.0.'

Asked if his company was fighting in a highly competitive market for talent where skilled staff had the choice to work in numerous other industrial sectors, Manfellotto replied 'no. One issue we have is the salaries in rail are in my opinion not enough.' Furthermore, he felt that 'although the initial attraction of rail supply careers is not maybe the same as aviation or automotive', once people had experienced the sector, they tended to find rewarding careers over the long term. 'I feel that to address this challenge, we must convince people earlier, especially children at school', he added. On this theme, Hitachi also intends to establish a joint technical academy bringing together universities in Japan, Italy and the UK, the three countries in which the company has its largest rail presence.

Schlaht echoed Manfellotto's view that the 'rail industry is changing.' 'It is no longer a business which is all about heavy steel and concrete – it is as much about artificial intelligence and innovation in software.' He also felt that the sustainability and environmental benefits of the rail business could give the sector an advantage over other industries when it comes to recruiting younger people, for whom green issues are widely held to be a greater concern than for older generations.

Amsted rail 'makes heavy use of internships, and also co-op programs with local universities, which is really worked out well', added Monaco. 'I would advocate that to anyone in the room. Once we get them in and show them that we are really actually doing things that are cool as opposed to what they thought railroads were all about before, they have a different perspective. And we have been able to retain a good percentage of the people we have brought in by doing that.'

Nevertheless, there was consensus among the panellists that there must be 'synergy' between skills so that traditional railway disciplines are not overlooked. 'It is not simple to achieve such a balance, recognising that most railways have a huge amount of legacy equipment still in operation', acknowledged Manfellotto.

Both Manfellotto and Schlaht felt that the liberalisation of the rail industry, especially in Europe, was also yielding more opportunity for suppliers to become directly involved in the maintenance of rolling stock fleets under so-called whole-life maintenance agreements. This in turn means the supplier is no longer just a manufacturer, it must also address the full lifespan of the fleet, working much more closely with the operator. 'I am a frequent rail traveller and of course I expect the train I am using to be clean, and for the toilet and air-conditioning to be working properly. So it makes sense for the supplier to be involved in this direct relationship with the customer', he added.

During the panel's concluding remarks, Jay Monaco urged suppliers to 'embrace technology and the changing nature of the rail industry so that you can attract and retain the next generation of people.' Jürgen Schlaht reiterated that 'the rail sector has a bright future in era of sustainability and "flight shame"', while Takao Nishiyama of J-TREC felt the supply chain's priority was 'to keep costs down but quality high.'

Plenary Session 3
Research and Development for Future Railways

Innovation for People and Technologies

Moderator: Prof. Roderick Smith
Future Railway Research Centre
Imperial College London, UK

This Plenary Session consisted of a panel discussion between six world leaders of railway research well known for their talent and strategic thinking, moderated by Roderick Smith (RS), Professor Emeritus of Imperial College London.

The members of the panel were:

- Dr. Norimichi Kumagai, (NK) President, RTRI, Japan
- Mr. François Davenne, (FD) Director General, UIC
- Ms. Luisa Moisio, (LM) Director of Research & Development, RSSB, UK
- Ms. Carole Desnost (CD), Chief Innovation Officer, SNCF, France
- Mr. Carlo Borghini (CB), Executive Director, Shift2Rail
- Dr. Zhou Li, (ZL) Chairman, CARS, China

The session was structured round two questions to which the panel responded in the order above, their replies identified by initials.

The first question posed was:

A key role of research is to identify and develop new and emerging technologies which will enhance and possibly transform the railways of the future.

What do you consider are the key technologies which should be investigated?

NK The main strengths of railways are safety, capacity and energy efficiency. The major challenge is to shift weakness into strengths. I see two major keys to achieving this switch. First, digital technology will become the driving force. Secondly, compared with the Automobile and IT industries where R&D budgets are around 6.7% of revenue, the railways industry spends only 1.2%. This figure needs to be increased.

FD Railways need to develop a system vision in line with the digital world we are living in. UIC is currently promoting tools to achieve this, in particular through the usage of conceptual models coming from the IT industry. Rail must become the backbone for low carbon mobility offering both:

- standardized internal interfaces allowing smart traffic management ;
- easy connection to other transport modes in order to make a reality of the concept of Mobility as a Service based on public transport services.

5G would be the main enabler to make it possible, UIC is working on its rail


Norimichi Kumagai
RTRI, Japan


François Davenne
UIC


Luisa Moisio
RSSB, UK


Carole Desnost
SNCF, France


Carlo Borghini
Shift2Rail, EU


Zhou Li
CARS, China

adaptation FRMCS (Future rail mobile communication system).

LM Identified the need to recognise and adopt/adapt emerging technologies, whilst recognising that the challenges were not nearly technological, but were about encouraging our workforce to embrace, not merely accept, changes made possible by new technologies, and this aim should influence our R&D thinking. Two tasks faced the railway: that of achieving greater automation, both in operations and maintenance, and making the railway easier to use for passengers, making their journeys more enjoyable and more productive.

CD Opined that mobility should be available and affordable to everyone and the experience of the passenger should be improved. Although demand for transport is always increasing, railways have in the past be slow to change. The top priorities should be competitiveness and decarbonisation. So, we are promoting innovation to reduce cost, to open new opportunities and to accelerate data exchange. The railway must rapidly become a smart system. Although railway already operate with a low carbon footprint, we can and must improve. SNCF will cease operating diesel trans by 2035, and we have already conducted research in hybrid, hydrogen and full battery operation, which will start being introduced as early as 2022/3. I conclude by stating that our efforts should encompass all stakeholders in railways and should be globally shared.

CB Asked I go back to the sentence you (RS) used to introduce this session? Research is what I do when I don't know what I am doing. In Shift to Rail we are running R&D to meet all the objectives discussed by the previous speakers. So competitiveness, decarbonisation automation and so on are certainly vital current topics. But at a meeting like this we have the opportunity to detach ourselves and ask about things we don't know. How will people want to travel in 10, 20, 30 years time? If we don't change our offerings for passengers and freight we will soon revert to a new legacy system and have the same problems. Collaboration is fundamental, we need to accelerate market uptake and

we need to direct the railway towards a service orientated culture.

ZL After RS congratulated China on building and operating nearly 30,000 km of high-speed line in the last 15 years, Zl responded to the first question as follows. He identified Intelligent and Green technology as the two major planks of railway research. He suggested that intelligent technology should cover the building phase (design, production and construction), the operations (from ease of use for passengers to the tracking of goods) and maintenance (making precise judgment on the condition of equipment and infrastructure, thereby reducing costs whilst ensuring safety). Green technology includes the use of new energy, new materials and modern information to reduce the impact of railway projects on the environment as much as possible, including the minimisation of land use. In the operation phase improvements will be made to train design to reduce energy, noise and emissions to make the railway even more sustainable.

The second question was then posed:

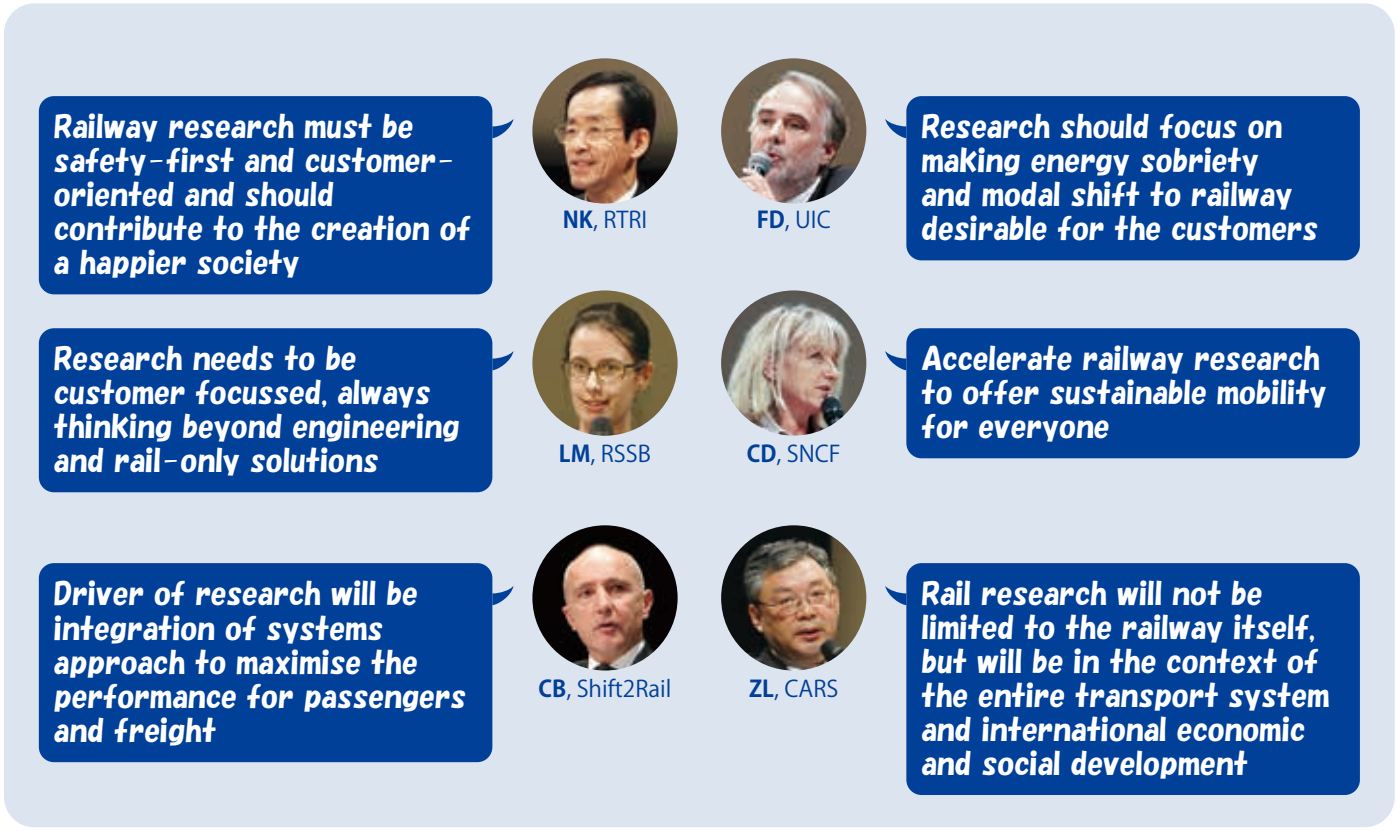
Railways own many aging and legacy assets. What research might be performed to manage these assets economically and effectively?

The Moderator reminded panelist that assets should properly include people.

NK Dealing with the deterioration of aging assets is prioritized by safety considerations. We are developing three approaches. First, is the increasing use of Condition Based Maintenance, which requires improved monitoring and intelligent analysis of data. Second, improving the performance of legacy assets, for which there are many technical challenges including cost effectiveness. Examples here include the rusting of bridges and the chemical deterioration of tunnel linings. Direct monitoring by commercial service trains is a priority, for

which AI techniques will be a key. Third, we are investigating the application of risk management techniques to asset management, again prioritized by safety. As far as human resources are concerned we are developing well planned training for R&D staff in cutting edge technologies and in field experience.

FD The long life cycle of many railway assets is good for sustainability: we are a frugal industry! At first sight, this seems to be an obstacle to innovation. On the contrary, at UIC we are convinced that a modular approach of innovation based on standardization is possible. It will pave the way to a savvy use of non-renewable resources. On this respect, I echo the comments of previous panelists : using digital thinking for designing the railway' s system architecture will allow to speed up innovation and promote modal shift. This future looking approach needs new thinking. We must communicate the desire of modernizing railways to young people that are committed to tackle climate change issues. We need their skills and enthusiasm to overcome the legacy/ innovation conflict.



LM Phasing out of legacy assets by gradual retirement comes at some cost and with possible increases in complexity, decisions are often incompletely informed. We need to think about agile implementation paths and system thinking to deal with both sides of interfaces. Much information of legacy assets is carried in the heads of retiring employees. This information needs to be retained: research on how to improve migrations paths is required.

CD Give an example of how automating the Paris Lyon operations could increase capacity by as much as 25%. The concepts of modular design and reinforced standardization could help to reduce the time cycle of innovation. There was agreement with many previously made points and a reiteration of the importance of attracting new people with new competences into the rail industry.

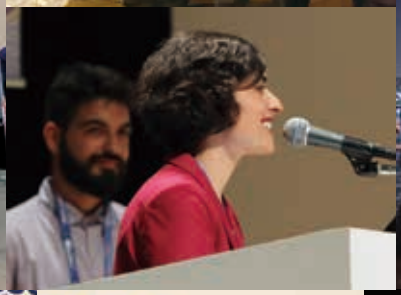
CB Agreed that complexity will increase, but it needs to be managed. The workforce is key, is rapidly aging and needs to be replaced. We need to adopt the concepts of the circular economy. Like airplane, we need to take as much of the system as possible onboard the vehicle. We need to develop resilience to climate change.

ZL China's railways have developed rapidly in the last 2 decades. A huge high-speed network has been built and building continues. The old meter gauge system is being developed as a tourist attraction. Freight and conventional lines have been upgraded and speeded up. Passenger demand has doubled and will grow more as the economy has developed. All countries face different issues, there is no common prescription.

The Moderator briefly attempted to summarise the panellists comments, before throwing a challenge to the panel. Could they summarise their view of the future of railway research in just one short sentence? Their responses provide a excellent, pithy, resume of the whole session (Above).

The Moderator concluded by thanking the panel members for their enthusiastic participation and for the thought they had given in the preparation of their excellent presentations, and apologised to the audience for having to truncate the discussion and having to omit questions from the floor because of time constraints. Enthusiastic applause indicted that the large audience has found the discussion both useful and stimulating.

Photo Gallery







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