Toward Railway Innovation

Ascent

Railway Technical Research Institute

No. 1
November 2016

www.rtri.or.jp/eng
JAPAN

Pioneering Cutting-Edge Technologies for the World's Railways

Message for the first issue of "Ascent"

Dr. Fuminao Okumura
Editor-in-chief
(Executive Director of RTRI)

The Railway Technical Research Institute has been conducting railway technical research and development in a wide variety of fields, and the outcomes have been utilized by a number of railway operators including the JR companies and manufacturers in Japan. In recent years, high-speed railways and urban transit systems have been playing more and more important roles in the world's transportation scene. I firmly believe that it will be even more important to use the technologies and expertise we have attained so far in order to further improve railways in the world. From this viewpoint, we launch this magazine "Ascent" in order to raise the global awareness and deepen the understanding of RTRI's activities among the world's rail-related people.

Last year, RTRI publicized its "VISION: RISING" message that described our mid- and long-term goals and strategies. This vision reads "we will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society." The launch of this magazine fits the policy described by this vision. The name of this magazine "Ascent" reflects our strong intention that we should keep ascending to realize this vision.

We already have another magazine written in English, Quarterly Report (QR), that is published as a journal containing detailed research papers written by researchers of RTRI. Meanwhile,this magazine, unlike QR which mainly is intended to reach researchers and engineers, is targeting a broad base of readers including management people at rail-related companies in the world. Therefore, we would like to make this magazine easy-to-understand and appealing to the readers who are not necessarily experts in railway technologies.

If the world's rail-related people might be able to better understand what RTRI is doing through reading this magazine, we could not be happier.

Ascent No.1 November 2016

Editor-in-chief	Dr. Fuminao Okumura (Executive Director of RTRI)
Managing Editor	Mr. Ryuji Tsuchiya (Director of International Division of RTRI)
Publisher	Railway Technical Research Institute
Address	2-8-38 Hikari-cho, Kokubunji-shi, Tokyo 185-8540, JAPAN
URL	www.rtri.or.jp/eng
Contact us	Public Relations, Railway Technical Research Institute
Mail Address	www-admin@rtri.or.jp

RTRI: Its Activities

The Railway Technical Research Institute (RTRI) started its activities on April 1, 1987 as an independent research organization by taking over the research and development activities of the former Japanese National Railways, upon establishment of the Japan Railway (JR) Companies.

In 2014, RTRI set out a new vision "RISING - We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society." This vision has been drawn up to define our mission of intensifying research and development for the innovation of railways and of generating useful outcomes. We have been intensifying R&D activities in order to pursue this mission.

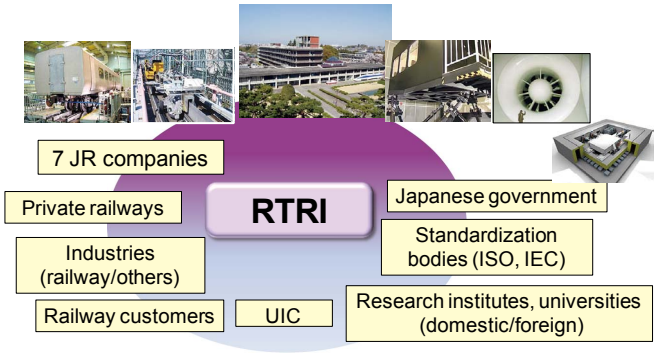
RTRI is now constantly pursuing innovation in railway technologies covering basic to applied research in the fields of rolling stock, civil engineering, electrical engineering, information technology, materials, the environment and human sciences. RTRI is actively advancing international research collaboration with railway operators, rail-related organizations and universities as well as promoting international standardization activities in railway fields.

Prof. Eisuke Masada Chairman **Dr. Norimichi Kumagai** President

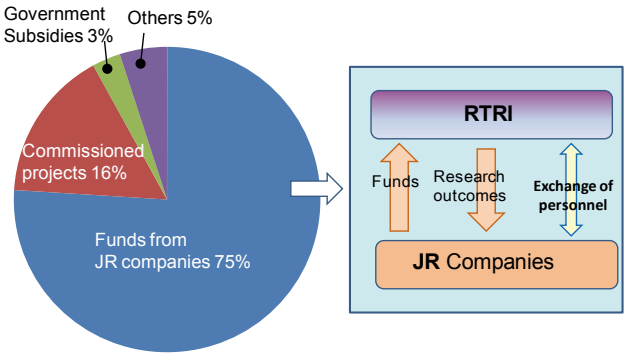
We have a solid relationship with seven JR companies in terms of funding, utilization of research results and personnel exchange. In addition to JR companies, we have a number of stakeholders including railway-related companies, organizations and standardization bodies. RTRI's revenue is funded by the JR companies(75%), individually-commissioned projects(16%), government subsidies(3%), etc.

We firmly believe that we can only establish trust with our customers through providing quality outcomes. For that purpose, we are determined to produce outcomes which will meet the rail operators' need promptly and precisely, as well as to address the challenges of improving safety, saving energy and increasing speed.

We have launched this magazine *Ascent* to introduce our state-of-the-art railway technologies.It would be our greatest pleasure if it can be read by a broad base of railway people including management officers as well as technical experts.



Stakeholders of RTRI



Business Foundation of RTRI

Driving Railway's Innovation

Part of RTRI's vision is to contribute to the further development of railways and the creation of a happier society by powerfully advancing research and development of innovative railway technologies. RTRI's president, Dr. Norimichi Kumagai will talk about the significance and the future prospect of research and development which enables further progress of railways, focusing on "digitalization of railways", "commitment to environmental and energy issues", and "further speed increase."

Innovation of Railways and the Role of R&D

Why is R&D a crucial part of innovation of Railways?

I think R&D is a key to railway innovation. Since the competition among different modes of transport is becoming intense, the pressure to reduce operational costs of railways is increasing. Moreover, due to the dwindling birth rate and an aging population, there is a serious concern about a potential shortage of skilled maintenance workers for railways. We should also continue to make every effort to keep railways safe or make them even safer. In order to cope with these difficult issues, we should invest in R&D and particularly in the development of technologies that are expected to bring breakthroughs for railway operations and achieve true innovation in the railway industry.

Dr. Norimichi Kumagai President

What do you think is important for promoting R&D which leads to innovation of railways?

RTRI is a research organization that provides technical solutions to railway organizations including railway operators, infrastructure managers, rail-related manufacturers, etc. In providing technical solutions for our clients, I think it is important to respond quickly to their needs and to social changes, and bring high-quality outcomes swiftly to the railway market. In other words, the turn-around time, from receiving requests from clients, to sending back the research results to them must be sufficiently short to meet

the clients' needs. In order to fulfill this mission, we have to improve the efficiency of R&D. We set out a new vision "RISING" in order to promote R&D leading to railway's innovation.

What do you think is required to improve the efficiency of R&D?

I would like to stress two points.

First, we need to carry out R&D swiftly by using field tests, advanced simulation and bench tests in a well-balanced manner. Among these methodologies, simulation technologies based on high-performance computing has already become an indispensable tool to improve the efficiency of R&D.

Secondly, for further promotion of R&D, railway-related organizations should share their issues, expertise and ideas and enhance collaboration in human resource development. Exchanging personnel among organizations is particularly effective for training younger researchers. Based on this idea, RTRI is promoting the secondment of researchers to foreign railway operators and universities as well as accepting researchers and trainees from overseas organizations.

Evolution of Railways by Digitalization

Could you give us some ideas how railway digitalization, which is rapidly progressing, contributes to the evolution of railways?

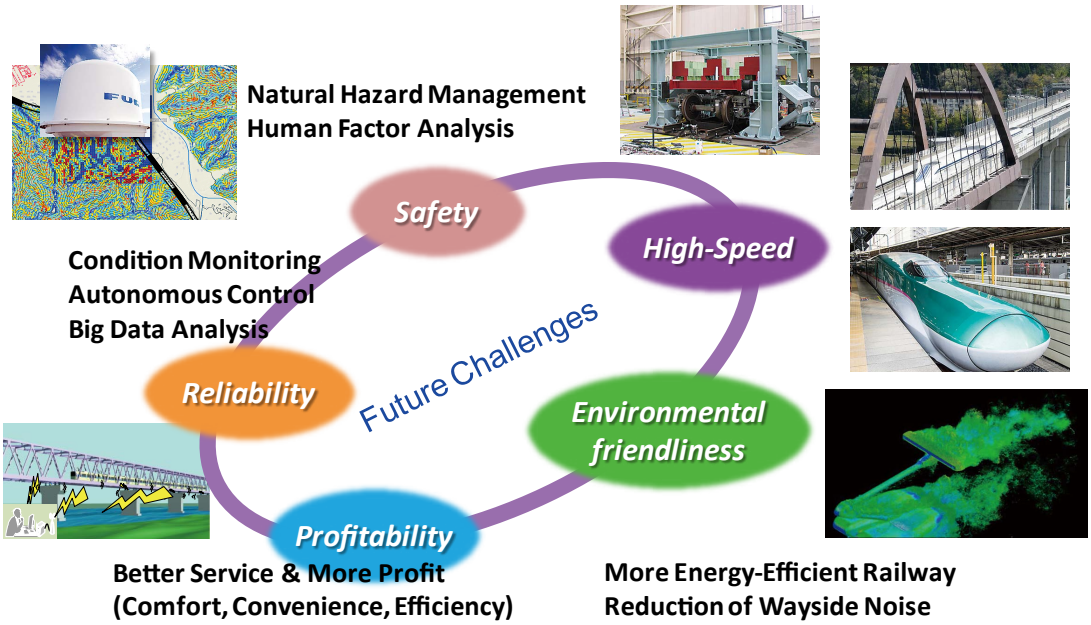
Railway digitalization leads to the improvement of safety, labor conservation and cost reduction. Emerging technologies such as artificial intelligence, image processing and big data analysis can greatly contribute to labor conservation and automation of railway operations. It is notable that these technologies have high potential to undergo rapid evolution, so that they can create higher value for railways.

It should also be pointed out that digitalization is useful for quantifying physical and physiological phenomena in an appropriate manner. Quantifying physical and physiological phenomena, which takes place in railway fields by using a variety of measuring tools and sensing technologies, will greatly contribute to the creation of measures for improving safety and efficiency of railways.

Could you please explain what we should keep in mind in promoting digitalization?

Let me give you an example. As automation progresses, human labor will be concentrated more on high-level decision making. We should note that ever-increasing importance will be attached to human error research, although the digitalization further progresses and more and more decision making is done by machines instead of by humans. Quantifying human behavior and decision making processes will be the starting point of future research into human error prevention. Among our R&D projects, RTRI has just started the basic research to develop a deeper understanding of human decision making processes using the latest brain measurement technologies in order to prevent human errors.

VISION of RTRI
RISING / Research Initiative and Strategy – Innovative, Neutral, Global –



Future Challenges for Railway Innovation

Energy and Environmental Issues

What do you think of the significance of the Paris Agreement adopted at COP21 in 2015 and its impact on railways?

At the twenty-first session of the Conference of the Parties (COP21) held in Paris last December, It was agreed that we keep the global temperature rise below 2 degrees compared to that of the Industrial Revolution Era and that every nation should evaluate the progress toward the goal of CO_2 emission reduction and revise the goal every five years.

The Japanese government has established a two-pillar program for CO_2 emission reduction in response to the outcome of the COP21: 1) further promotion of energy conservation and 2) choice of an energy source that emits less CO_2. In the transportation field, we are also required to commit ourselves to further energy conservation and CO_2 emission reduction.

The railways have a great feature of being able to carry passengers and freight with high energy efficiency and low carbon emission. In order to reduce the environmental impact of the whole transportation, however, it is important for each nation to shift as much as possible their transport demand to public transportation modes with high energy efficiency such as railways.

Could you please give us your opinion on how the railway sector should cope with energy and environmental issues?

Other modes of transport including automobiles are actively improving their environmental performance by adopting various emerging technologies. We should not be satisfied with the current status of railway's environmental performance, but further reduce energy consumption of the entire railway systems. In other words, railways should go beyond this, to the next step. The railway sector should further improve its high energy efficiency and low carbon emission, and lead the energy innovation of industries. I am confident that we can do that with the power of R&D.

For Further Speedup

Could you please give us some comments on the prospect of further speed increase on railways?

In order to establish the advantages of railways over competing transport modes such as aircraft and automobiles, we need to make railways more appealing to customers by further increasing speeds and shortening the journey time。

Currently, we are promoting research and development to raise maximum speeds of trains to 360-400 km/h for rail/wheel systems. Meanwhile, the superconducting Maglev systems can provide 500 km/h train services and will be a major driving force to innovate railways.

At the same time, a key challenge for

achieving safety is to reduce braking distances. Since, in case of earthquakes, high-speed trains need to be decelerated immediately from the speed of 360 km/h and stop completely within less than 4000 m braking distance, we have to develop non-adhesive brakes such as aerodynamic and track brakes.

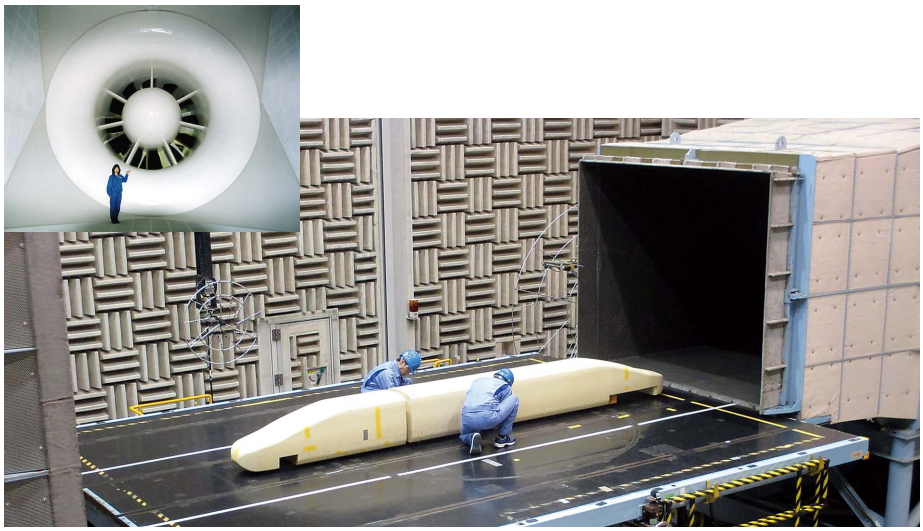
I would like to hear your comments on the technical challenges that you are facing in order to increase railway's speeds.

The biggest challenge is how to address environmental issues. As the train speeds are raised, aerodynamic impacts that affect vehicle noise and vibration are greatly intensified. For example, the energy to generate aerodynamic noise increases in proportion to the sixth power of train speed. Among many of the issues caused by aerodynamic phenomena, in particular aerodynamic noise and tunnel micro-pressure waves need to be addressed most urgently.

Please give us a specific example of a technology challenge you are addressing in developing measures to reduce noise.

It is essential to reduce noise generated by pantographs and bogies, which are major noise sources. Pantographs' shapes have already been improved so far in order to reduce noise. The lifting force acting on low-noise-type pantographs tends to fluctuate greatly, however, and the current-collecting performance in high-speed running might be damaged. So, we have to develop a technology to satisfy both the requirements for current-collecting performance and noise reduction at the same time.

Based upon these challenges, RTRI has been working for a new current-collection system which will meet further speed increase.



Preparing for a wind tunnel test

World Congress on Railway Research (WCRR)

The 11th congress of WCRR has just been held successfully. What do you think is the most significant feature of WCRR?

WCRR has evolved to be an international congress of an incomparable scale which covers wide technical areas of railways and it provides a forum to gather and share information on world railway research.

Cross-organizational, cross-border collaborations are quite important for achieving railway innovation. WCRR has already been providing good opportunities to start such collaborations.

It is important to enhance WCRR's values as a stage where world's railway research institutes will be able to understand the global trends of railway technologies, reflect them on their research activities and further develop future railway technologies.

The next WCRR will be held in Tokyo. Could you give us some comments on this?

This is the second WCRR to be held in Japan, following the first time in 1999.

Currently, Asian railways are facing an age of drastic changes. In the countries which have been achieving remarkable economic growth, urban transit systems are being developed rapidly and many countries have plans to build high-speed railways and dedicated freight railways. In Japan, we have also been steadily promoting the development of urban transit systems and expanding the Shinkansen network which will have tremendous impactst in revitalizing the Japanese local economies.

I hope that the next WCRR in Tokyo will attract railway-related people's attention to Asia, where railway industries are enjoying the most robust growth and performance in the world, ignite innovative rail research, and contribute to connecting people in different countries and communities by railway networks and attaining a happier society.

The Origin and the Evolvement of WCRR

The World Congress on Railway Research (WCRR), which originated in the international railway research seminar held by RTRI in 1992, has evolved to be the world's largest international congress on railway research. Ryuji Tsuchiya, the director of international division gives a brief overview of the history of WCRR in this article.

Birth of WCRR

In October 1992, an international railway research seminar was held in Tokyo hosted by RTRI as one of the commemorative events of the 5th anniversary of RTRI. The speakers of the seminar were top R&D executives of major railways in the world including Roy A. ALLEN, Vice President of AAR, George W. BUCKLEY, Managing Director, Central Services of British Railway Board, Theo RAHN, President of the Technological Center of DB, Philippe ROUMEGUERE, Assistant Director General of SNCF and Kainen WATANABE, Executive Vice President of RTRI.

On this occasion, RTRI's proposal for founding the World Congress on Railway Research was agreed upon by all the members present at the seminar and the organizing and executive committees of the congress were established. UIC and Italy also participated in these committees later.

International railway research seminar in 1992

The first WCRR in Paris in 1994

Overview of the past congresses

The first congress was held in Paris in 1994 hosted by SNCF with 1370 participants. The congress takes place at least every 3 years. An overview of the past congresses is listed in Table. In October 1999, WCRR 1999 was held in Kunitachi Headquarters of RTRI in Tokyo. The most recent congress was held in Milan from May 29th to June 2nd. It has been decided

that the next congress will be held in 2019 in Tokyo.

Current Status of WCRR

WCRR has become the world's largest international congress dedicated to railway research, where researchers and engineers in diverse fields of railway technologies get together from all over the world to present their latest research results and to share ideas and experiences for promoting the innovation of railways. In addition to the oral/poster presentations of scientific/technical papers, plenary sessions and exhibitions are also featured. Plenary sessions often include round tables involving senior management of major railway operators, infrastructure managers, rail-related manufacturers and other stakeholders of railways.

The congress in Milan covers such areas as 1) rolling stock, 2) infrastructure, 3) railway system (including signalling and train control systems), 4) passenger mobility, 5) freight logistics, 6) sustainability, 7) operation and safety and 8) economics and policy. It should be noted that in addition to purely technical matters, issues related to social and financial processes for deploying railway technologies are also discussed in the congress.

Organizing/Executive Committees of WCRR

WCRR is governed by the joint activities of WCRR committees. The senior committee is called the "Organizing Committee" (ORG, for short) and reporting to it is the "Executive Committee" (EXE for short). The permanent members of the WCRR committees are SNCF (France), DB (Germany), Trenitalia (Italy), RSSB (United Kingdom), RTRI (Japan), TTCI (USA) and UIC (International Union of Railways). In addition to the permanent members of WCRR, special membership can be conferred on other organizations that have been approved to host future WCRR events. Canadian, Korean and Australian organizations took part in the committees in order to host WCRR 2006, WCRR 2008 and WCRR 2013, respectively.

WCRR '99 at RTRI in Tokyo in 1999

Overview of the Past WCRR

Edition	Location	Year	Month	Number of participants	Congress Theme
1	Paris	1994	11	1,370	Managing the Strategic Fields of Railway Research in the 21st Century
2	Colorado Springs	1996	6	490	Seeking, Creating, and Developing International Railroad Research Partnerships
3	Florence	1997	11	1,560	Future Railways Need to Halve Costs, Double Productivity and Remain Environmentally Friendly
4	Tokyo	1999	10	740	New technologies create new opportunities for the railways and society of the 21st century
5	Cologne	2001	11	1,050	Market - Products - Technology
6	Edinburgh	2003	9	700	From Birth to Renaissance
7	Montreal	2006	6	750	Progressing Together
8	Seoul	2008	5	800	Towards a Global Railway
9	Lille	2011	5	800	Meeting the Challenges for Future Mobility
10	Sydney	2013	11	560	Keeping Ahead of the Curve through the Sharing of Knowledge
11	Milan	2016	5-6	1,000	Research and Innovation – From today towards 2050

WCRR – From Milan 2016 to Tokyo 2019

The 11th World Congress on Railway Research (WCRR 2016) was held in Milan from May 29 to June 2, hosted by Trenitalia. Mr. Marco Caposciutti and Mr. Alessio Gaggelli of Trenitalia report on the Congress.

Marco Caposciutti
Chief Technology Officer
Trenitalia
the chairman of the WCRR Organizing Committee

Alessio Gaggelli
Locomotives Procurement Manager
Trenitalia
a member of the WCRR Executive Committee

The World Congress on Railway Research (WCRR) is the most relevant worldwide event concerning railway research; within the congress frame railway undertakings, infrastructure managers, universities, research institutes and the most important railway industries have the opportunity to promote their ideas, visions, upcoming projects and share results and outcomes of the recent ones.

The WCRR is an association with the main following aims:

- promoting railway research at international level;
- promoting innovation, communication and collaboration among all the organizations that operate in the railway field and the institutions;
- organizing roughly every 3 years a world congress on railway research and innovation.

The founding members of WCRR are:

- AAR/TTCI (Association of American Railroad / Transportation Technology Center Inc., USA)
- Deutsche Bahn AG (Germany)
- RSSB (Rail Safety and Standard Board, UK)
- RTRI (Railway Technical Research Institute, Japan)
- SNCF (France)
- UIC (International Union of Railways)
- Trenitalia (Italy)

The first congress was held in Paris in 1994; since then other editions followed and were held in:

- Colorado Springs, 1996
- Firenze, 1997
- Tokyo, 1999
- Cologne, 2001
- Edinburgh, 2003
- Montreal, 2006
- Seoul, 2008
- Lille, 2011
- Sydney, 2013

The 11th edition of WCRR has been hosted by Trenitalia (the railway undertaking of FS Group) and has been held in Milan from 29th May to 2nd June at the Stella Polare Congress Centre.

Barbara Morgante
(CEO, Trenitalia)

Augusto Mensi
(CEO, Lucchini RS)

Per Allmer
(President of Western Europe, Middle East and Africa Region, Bombardier Transportation)

Jean-Pierre Loubinoux
(Director General, UIC)

The theme chosen for this edition of the congress has been *Research and Innovation from Today Towards 2050*. Such a theme underlines how the railway research has to face the innovation challenge, having a vision towards far future and keeping in touch with a significant glance to applications focused on improving railway services in the brief or middle time.

The congress has been set out in 3 days, each one with an initial plenary session in which worldwide keynote speakers given a strategic perspective of the railway research also compared with others views belonging to different fields than railway (*e.g.* chemical). **The detailed themes addressed in the 3 plenary sessions have been "Customers, market & competition", "Technology & processes innovation", "Research from different perspectives", all of the three themes shared a common root "…from today to 2050".**

All the papers presented during the 3 congress days have been clustered in 2 main sessions, one dedicated to **Vision & Future** and the other devoted to **Today's Research.**

Papers presented in the Vision & Future were dedicated to studies and proposals concerning long term applications, with the aim to improve the whole mobility system towards the horizon of 2050. These papers has been developed according to 8 specific themes:

Panels along entrance side at Stella Polare Congress Centre

- **Rolling stock**
- **Infrastructure**
- **Railway system**
- **Passenger mobility from door to door**
- **Freight logistics**
- **Sustainability**
- **Economics and policy**
- **Operation and safety**

Papers shown in the Today's Research were dedicated to application for a near future with the aim to improve the railways system based on the already available railway system. These papers addressed 34 different sub-themes or topics.

For the first time with respect to the other editions of the congress, it has been possible to present and show projects and studies through the two innovative communication ways, that is

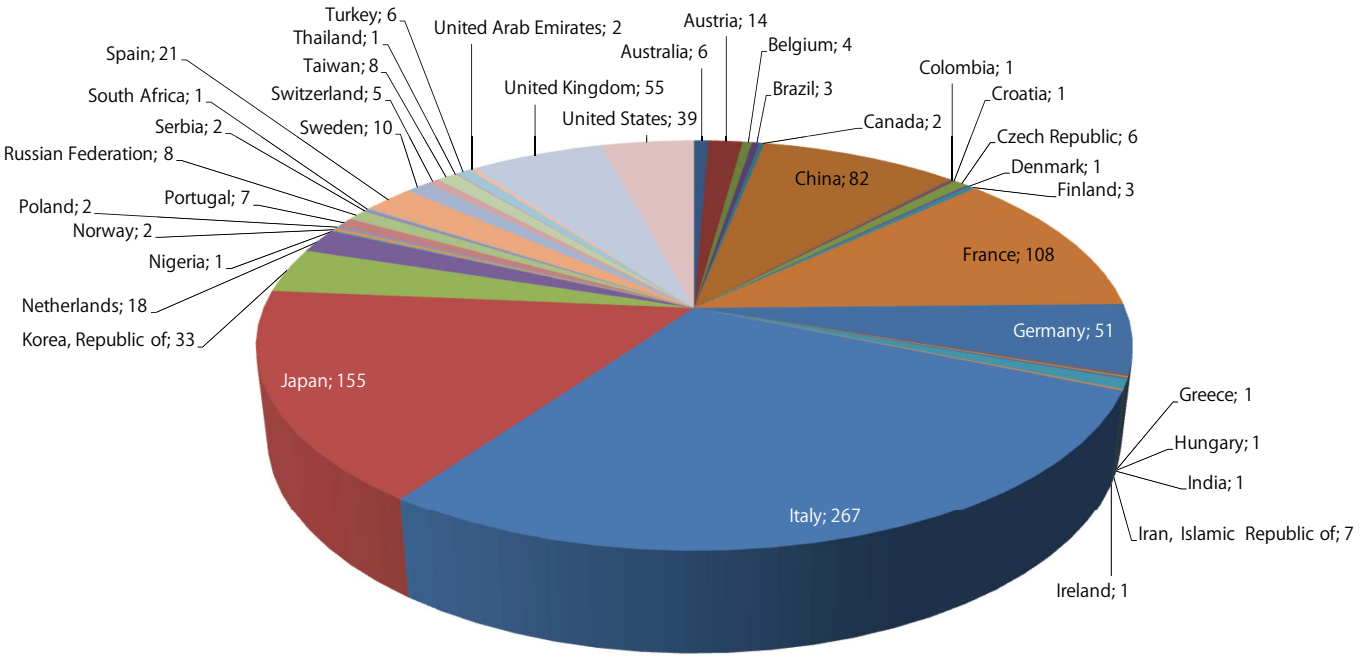
- **e-poster**
- **Proof of Concept**

so that specific congress areas were arranged allowing researchers to give particular emphasis to their short term applications by means of practical demonstrators.

Moreover, this Congress edition hosted also a rolling stock exhibition, it has been set up inside Trenord's Fiorenza maintenance plant, a suitable room located very close to the Stella Polare Congress Centre; **the exhibited rolling stock shown innovative features, both in regional/ commuting transport services as well as in high speed travelling.**

The congress organization began 2 years and half earlier and it has been accomplished mainly thanks to the support of the WCRR Organizing and Executive Committees. One of the most important task has been the papers selection. An experts panel of worldwide specialists belonging to several domains has ranked and selected the papers via a web application, resorting to a blind and multi-reviewer rating process. **Many abstracts has been submitted from all over the world,** collecting more than 900 abstracts.

The outcome of the papers selection process has been the acceptance of **72 speeches in the Vision & Future session and 240 speeches in the Today's Research session. In addition to that about 150 papers have been shown as e-poster. Congress registered delegates have been more than 1100.**



More than 900 abstracts coming from 38 countries

Handover ceremony to WCRR 2019 in Tokyo – Dr. Kumagai, Mr. Caposciutti, and Dr. Okumura

During the congress final day 11 awards have been assigned, just 8 to papers belonging to 8 different congress main themes, 1 to the most attractive e-poster, 1 to the most interesting Proof of Concept and 1 to the youngest researcher.

Above the congress outline and figures, we believe that it worth sharing some outcomes and messages rose during the three Congress days.

First of all the common idea for the future is not to consider only the "railway system" but the whole "mobility system".

Furthermore, among the most important available tools able to improve efficiency to the whole mobility system arose digitalization and "big data system applications" for predictive maintenance, circulation managing and CRM.

Great efforts must be done to increase the infrastructure capacity by means of technology enhancement instead of with just growing up new infrastructures: for this reason great interest has shown by ERTMS High Density.

In order to decrease operational costs driverless trains applications (Automatic Train Operator) can be actually foreseen in the railway services and not only in metro application.

Besides, it is fundamental to pay attention to "sustainability" and to the "environmental matters" in order to preserve and build a "more green" world.

Finally, the suggestion of Hyperloop has been presented as a side event, having a look to the state of art of the technology and evocating future exploitation.

The edition of WCRR 2016 has brought also a great contribute in knowledge, exchange of experiences and fruitful networking environment among all the mobility partners confirming the importance in pursuing with the promotion of this kind of events. The next WCRR edition (the 12th edition) will be hosted by RTRI in Tokyo in 2019. We send our personal best wishes to the Japanese colleagues for the efforts they should face, assuring them all our care and showing them our gratitude for the effective support they gave us.

Japan and RTRI Enlivened WCRR 2016

Stepping forward to WCRR 2019

In WCRR 2016, a total of 92 presentations including 66 oral presentations (24 from RTRI) and 26 poster presentations (8 from RTRI) were delivered by Japan. This ranks the second place (after Italy) among the countries that participated in the congress. Shuichi Myojo, manager of International Division reports on the contributions from Japan and RTRI.

Plenary Sessions

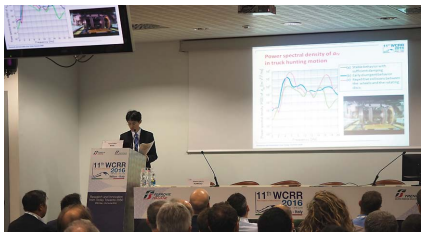
On May 30, WCRR 2016 began with the opening ceremony, followed by Plenary Session 1 entitled "Customers, Market & Competition" with Masaki Ogata, Vice Chairman of JR East participating in the discussions as one of the panelists. In Plenary Session 2 on May 31, "Technology & Innovation," RTRI's President Norimichi Kumagai joined the panel discussion.

Mr. Ogata stressed that Information and Communications Technologies, including the Internet of Things, Artificial Intelligence and big data perfectly fit the needs of railways which require a tremendous amount of infrastructure and provide transport services to a vast number of customers. He also pointed out the increasing importance of open innovation including international collaboration.

Dr. Kumagai stressed that it is essential to increase the efficiency of R&D and to combine a wide variety of research techniques, including advanced simulation technologies in a well-balanced manner. He also mentioned the necessity of further improving the advantages of railways in areas of high energy efficiency and low carbon emissions, and introduced the latest research efforts of RTRI.

Oral Sessions

Japanese participants made 66 oral presentations, 24 of which were from RTRI. This was the second largest number behind Italy and it helped improve the presence of Japan. Specifically, the presentations from RTRI were made on the research outcomes about performance and soundness evaluations, condition monitoring and diagnosis of facilities mainly in the fields of structures, track and catenaries. Furthermore, in the fields of communication technologies, train control /operation management systems and rolling stocks, the researchers made presentations on the application of new technologies and on proposals for new systems.



Mr. Yoneyama presented his paper entitled "Durability analysis of the fuel cell by the test rail vehicle", in which he reported the result of durability test of a railway vehicle powered by 100 kW-class fuel cells. For fuel cell vehicle, please see also Page 20.

Dr. Watanabe presented his paper entitled "Performance Evaluation for Long PC Extradosed Bridges", in which he discussed the applicability of two types of PC extradosed bridges to high-speed railways through the analysis of dynamic interaction between vehicle and structures as well as measurements. (An extradosed bridge is a hybrid between a box girder and a conventional cable-stayed structure.)

Awards

The awards for outstanding research papers were given for eight oral presentations, one for each of the eight research fields, one poster presentation and one Proof-of-Concept presentation. A special award for young researchers was also given to one researcher under the age of 30. From among Japanese researchers, Yoshikata Tanabe of JR Central won the award for the outstanding research paper in the field of "Operations and Safety."

Exhibition

At the technical exhibition which was open in parallel with the presentation sessions, 29 companies and organizations participated. From Japan, JR East and Hitachi Ltd., participated as well as RTRI and other JR group companies. RTRI ran a display booth, exhibited posters and brochures to introduce RTRI and JR companies and did promotional activities for the WCRR 2019, 12th congress to be held in Tokyo.

Promotional Activities of WCRR 2019

The next WCRR congress is to be held at the end of October 2019 in Tokyo. At the Closing Ceremony in Milan, Marco Caposciutti of Trenitalia handed over the position of the Chairman of the WCRR Organizing Committee to RTRI's Executive Director Fuminao Okumura. Executive Director Okumura expressed his thanks and respect to the efforts of the Italian Organizing Committee which successfully completed WCRR 2016. He referred to the significance of the next WCRR congress being held in Asia, a region showing rapid progress in economy and railway technologies. Furthermore, he expressed his hope that many people will come to Tokyo from around the world and understand the vital role that railways play in the Japanese economy and society.

Commitment to Developing Solutions to Energy Issues

Railway systems have been superior to other transport modes in resolving energy issues due to their advantageous features: higher energy efficiency and lower CO_2 emissions. However, the automobile and aircraft industries have performed systematic and proactive research and development to find solutions to energy issues and have made breakthroughs. The railway sector needs to make more effort to conduct research and development to further upgrade its features of higher energy efficiency and lower CO_2 emissions. Mr. Hiroyuki Nozawa, General Manager of International Division gives an outline of RTRI's R&D activities on energy issues.

Implications of COP21

As you may remember well, the twenty-first session of the Conference of the Parties (COP21) was held in Paris last year (December 2015) , where the Paris Agreement was adopted to set out a framework for global warming countermeasures, following the Kyoto Protocol of 1997. In Europe, the International Union of Railways (UIC) held an event named "TRAIN to Paris" in conjunction with COP21, and had a series of trains run to Paris from different parts of the world to highlight how effective energy efficient rails are in the prevention of global warming.

Meanwhile, the Japanese government has established a two-pillar program for CO_2 emission reduction in response to the outcome of the COP21: 1) further promotion of energy saving and 2) choice of an energy source that emits less CO_2. In the transportation field, we are also required to commit ourselves to further energy saving and CO_2 emission reduction.

In recent years, many of the Japanese railway operators have been operating an environmental management system (EMS) conforming to the ISO 14001 standard. The EMS has established specific environmental goals including energy issues, and the PDCA (Plan-Do-Check-Act) cycle is employed for management to reach the goals.

Commitment to solutions to energy issues in the railway field

Compared to other modes of transport, railway systems have the advantage of being able to transport passengers and freight with higher energy efficiency and lower CO_2 emissions. Railways by their nature are energy efficient due to little rolling resistance of wheels on rails and technological developments have brought about the reduction of vehicle weight, introduction of regenerative brakes and other advancements, all of which have contributed to the current high level of energy savings.

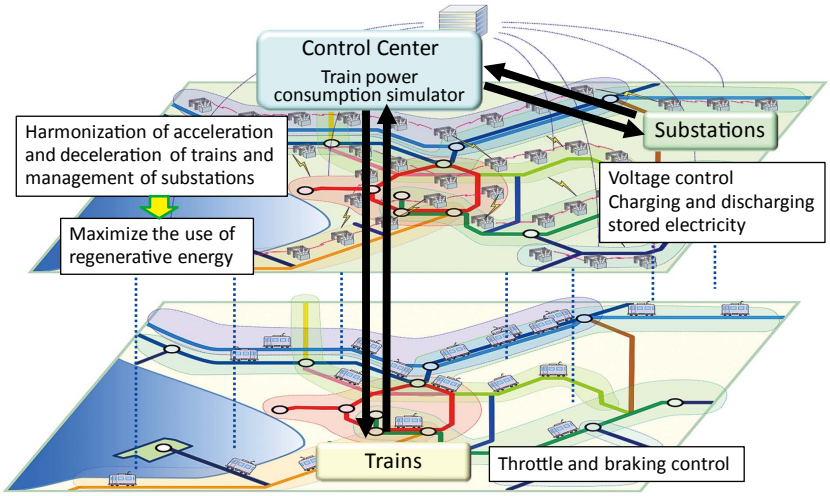
-25.4%

Japan's intention of greenhouse gas reduction by 2030 compared to 2005

"We will mobilize all measures to promote thorough energy conservation and introduce renewable energies to the greatest possible extent."

(Japan's Prime Minister Shinzo Abe stated in his policy speech to the 189th session of the Diet on Feb.12, 2015.)

Concerning the other target of having an energy source emitting less CO_2, the railway industry has made efforts to generate in-house power for their system operations by hydroelectric power generation for a long time. Additionally in recent years,



Concept of networked energy conservation
where the control center, trains and substations work cooperatively

photovoltaic power and wind-power generation systems have been installed on railway property including station roofs and railway land.

In recent years, hybrid-driven vehicles using diesel electric power and storage batteries have been developed and are in practical use in railways all over the world. In Japan, hybrid-driven passenger diesel cars and shunting diesel locomotives are in practical use and have started to replace the existing diesel vehicles for energy saving.

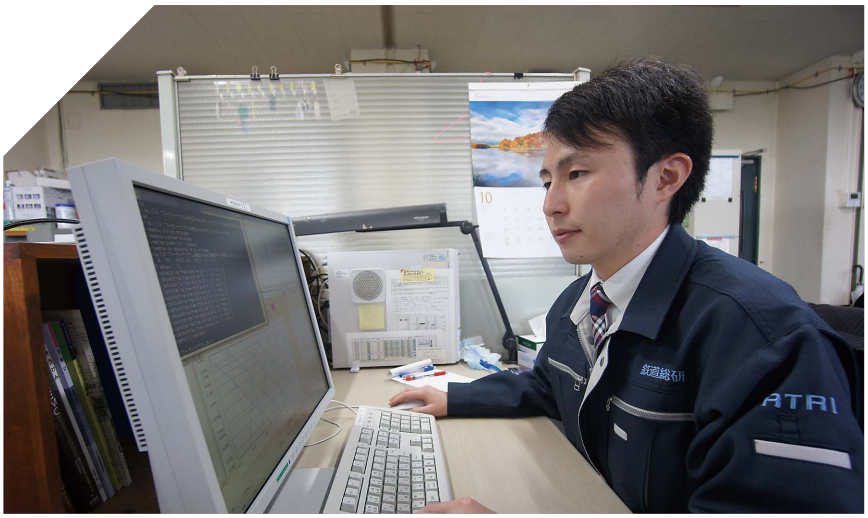
Around urban areas, the sections between urban centers and major stations are often electrified, and the sections beyond them are sometimes non-electrified. To achieve energy saving in such cases, battery-powered vehicles are in practical use. Electric storage vehicles can run in non-electrified sections, using the energy of their power storage devices which are either charged during running in electrified sections or by using chargers installed at the stations in non-electrified sections. In Japan, battery-powered EMUs available for DC feeding systems were put into actual operation and electric storage vehicles available for AC feeding systems has just been put into operation in October 2016. In Europe as well, electric storage vehicles were put into practical use and are used for trams, etc.

Thus energy issues have been addressed in railway systems, but other means of transport have also proactively introduced new technologies and started to greatly enhance their environmental performance. Accordingly, railway systems need to further upgrade their environmental features, which are high energy efficiency and low CO_2 emissions, and continuously keep their energy advantages in the future. This requires the railway industry to advance to the next level. The following sections introduce the directions of research and development for that purpose.

Replacement by energy source emitting less CO_2

Replacement of internal combustion engines by fuel cells as an energy source emitting less CO_2 is one of the most promising technologies. A fuel cell is a device to generate electrical energy and water by chemical reaction of hydrogen and oxygen. Since no CO_2 emits from a fuel cell vehicle, the device is known to be greatly effective in achieving reduction of CO_2 emissions. In the automobile field, vehicles loaded with fuel cells are already commercially available.

As described elsewhere in this magazine, RTRI started making efforts to develop fuel-cell vehicles about 10 years ago and is currently performing a running test to determine the long-term degradation characteristics of fuel cells and is advancing the technological developments toward



Simulating changes of energy consumption of trains in accordance with the change in train schedule

practical application.

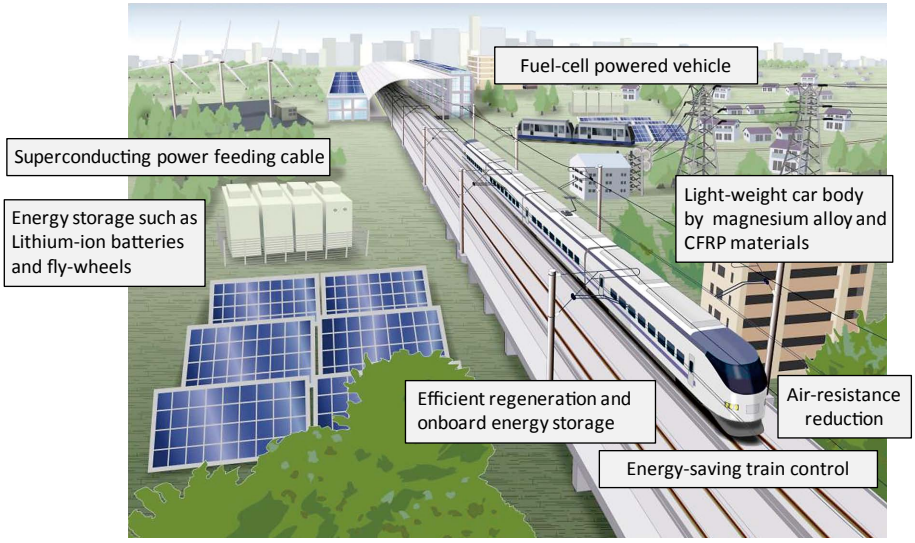
Expectations for further technological innovation

For further technological innovation, development of silicon carbide (SiC), which is a next-generation semiconductor element, is progressing in many countries. In Japan, research and development is being advanced to adopt silicon carbide (SiC) in traction inverters. Achieving further energy savings is expected by reduction of semiconductor loss and the decrease of vehicle weight due to reducing the size and weight of the inverters.

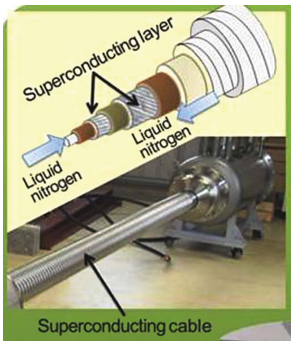
RTRI is also conducting research and development of superconductive feeder cables that enable power transmission without electrical resistance by applying superconductive material to feeder cables. DC feeding systems have issues such as transmission loss and voltage drop, which are attributable to the electrical resistance of feeder cables. If superconductive feeder cables are put into practical use, these issues will be reduced. These cables will be effective in load leveling at substations in addition to energy saving due to reduction of transmission loss and regeneration canceled.

Smart grids are being studied worldwide to develop an electric power network that performs communication and control functions and proactively utilizes an energy source emitting less CO_2. RTRI is also proceeding with research and development for further energy savings by transforming the railway power network into a smart grid. If we are able to construct a smart grid that can control the power networks of an electric power company and railways integrally in the future, it is expected to be extremely effective in achieving energy saving and utilization of an energy source emitting less CO_2.

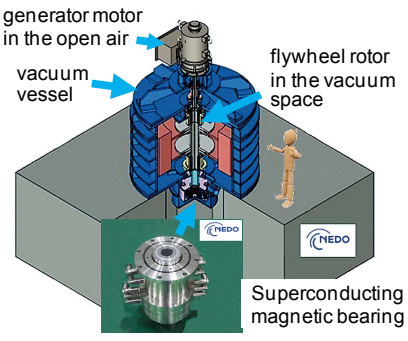
Mixing chemicals in a mortar to prepare a compound for a ceramic superconductor



Technological innovations addressing energy issues



Superconducting power feeding cable



100 kWh flywheel with superconducting magnetic bearing

Research in the Spotlight

Aiming at Non-Fossil-Fuel Railways: Development of Fuel Cell-Powered Trains

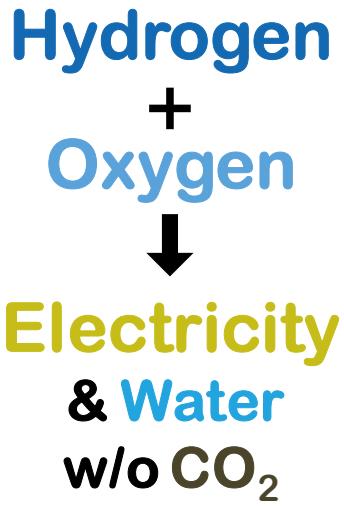
Dr. Hitoshi Hasegawa
Laboratory Head
Hydrogen and Sustainable Energy

In our interview, Dr. Hitoshi Hasegawa, the head of the Hydrogen and Sustainable Energy Laboratory at RTRI and engaged in the development of railway vehicles powered by fuel cells, told us about the background of the development, the results achieved up to now, and the prospects for the future.

Why did you start the research on fuel cell-powered vehicles?

Non-electrified sections account for approximately 40% of the railway line extensions in Japan. On these lines and in many parts of the world, diesel-powered vehicle operations are common. Diesel vehicles use a fossil fuel of course and have a number of issues, primarily: carbon dioxide is emitted from the vehicles; vehicle vibration and noise are greater than those of electric trains; and maintenance takes a lot of labor and time. Moreover, in order to operate continuously between electrified and non-electrified sections, diesel vehicles are running even in the electrified sections. This current status quo can be improved by running electric trains even in the non-electrified sections. This would reduce global environmental burdens, diversify fuels, reduce vibration and noise, and enhance vehicle maintainability. As an option for the application of electric trains to non-electrified sections, battery-powered trains have already started practical commercial operation. However, we thought that the real target we should go after was the development of fuel cell-powered trains in order to extend the running distance compared to batteries. That was the reason why we started the development of the fuel cell-powered trains in 2000.

Demonstration run of fuel cell-powered train (in 2000)

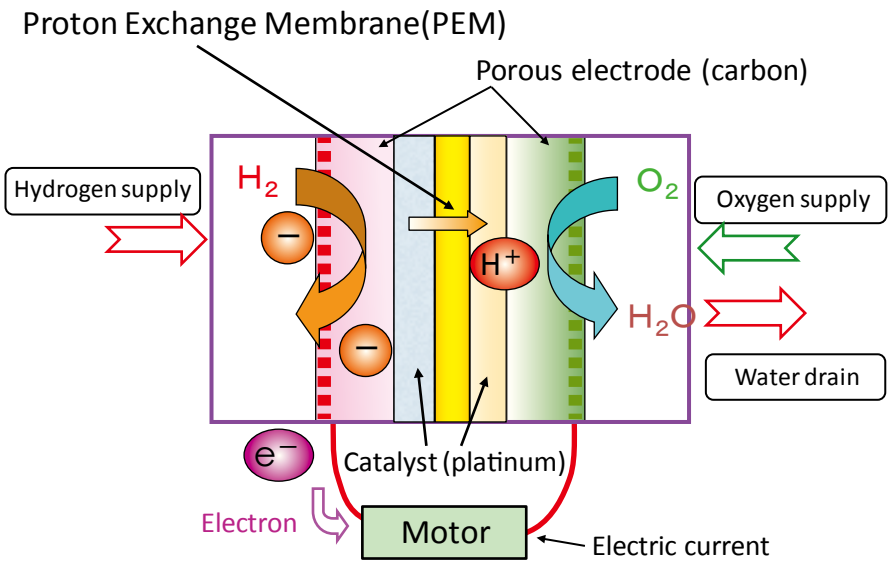


Please tell us the results that you have achieved up to now.

We conducted the world's first manned demonstration run of a train using a proton exchange membrane fuel cell on a garden railway. Then in 2006, we performed a running test and a bench test on a full-scale railway vehicle loaded with a proton exchange membrane fuel cell (produced by

Filling up the tank on the RTRI's full-scale prototype vehicle with hydrogen

Test run of full-scale prototype vehicle (in 2006)



How a fuel cell works

Prototype of liquefied hydrogen storage container (in 2012)

Nuvera, gross output 150 kW) and a carbon fiber reinforced plastic composite, high-pressure gas storage cylinder (produced by Dynetek Industries; 35 MPa, 210 m^3 at standard temperature and pressure, i.e. 0°C and 1.0 bar), prior to anyone else in the world. The test vehicle was then replaced by a prototype train with a fuel cell / lithium ion battery hybrid system, which was used for the measurement of energy consumption and operated for durability verification where degradation characteristics for as long as 10 years were documented. At WCRR 2016 in May 2016, one of our researchers reported the result of this durability test. Furthermore, in 2012 as a part of the study of a method for installing dense hydrogen, we produced an experimental liquefied hydrogen storage container and performed a test to measure the latent heat of vaporization at the fixed position, where the boil-off characteristics were determined.

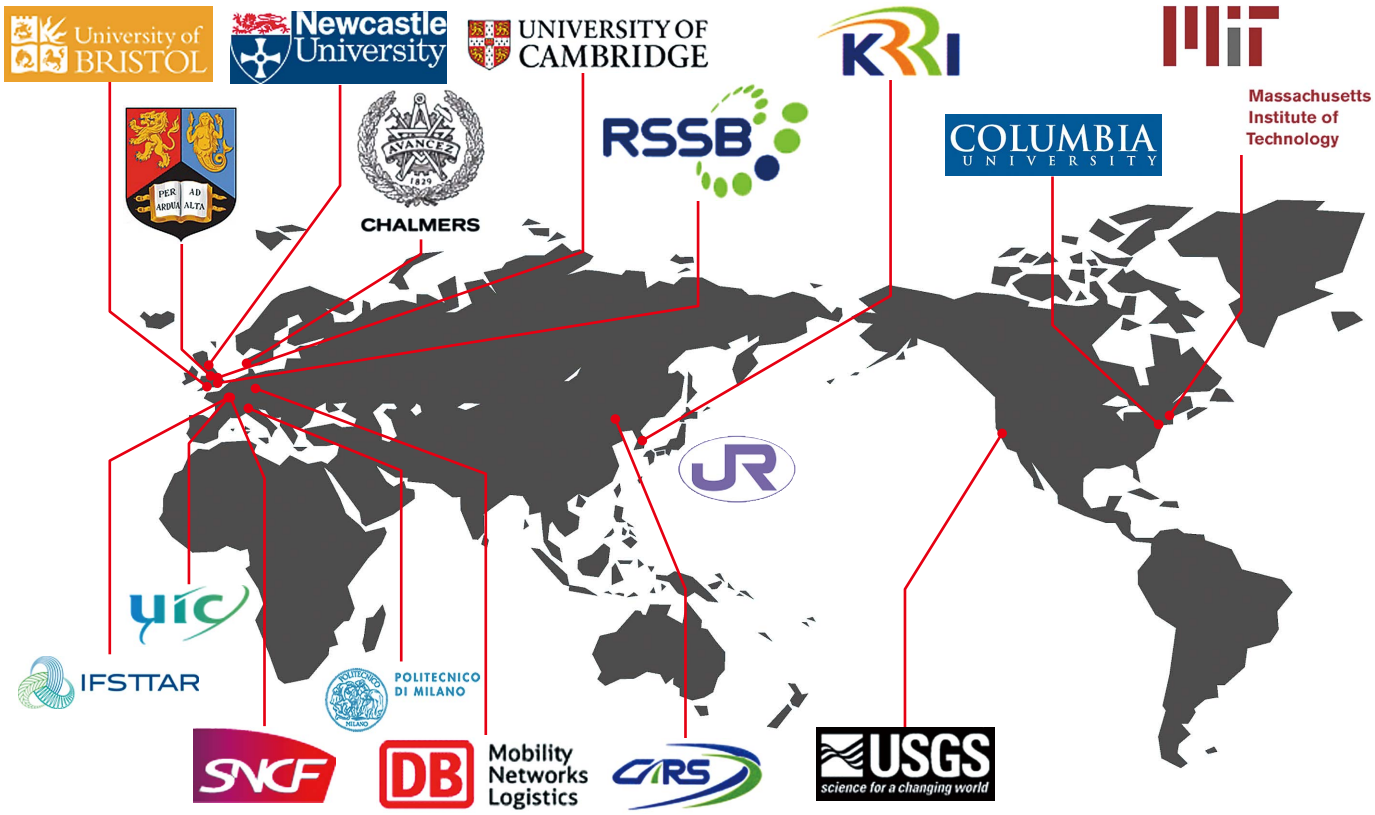
Concerning the development of fuel cell-powered trains, could you tell us your prospects for the future?

In Japan, hydrogen fuel cell vehicles are available in the market, and hydrogen stations are under construction nationwide. Thus utilization of hydrogen energy to moving vehicles is making steady progress. Railways are not an exception and there are high expectations for the practical application of hydrogen fuel cells to provide power to trains. RTRI is planning to continuously advance the technical development towards practical use.

Overview of RTRI's International Activities

RTRI is actively advancing international research collaboration with overseas universities and rail-related businesses. For the past three years, we have established collaborative relationships with 16 foreign organizations and sent 20 researchers overseas mainly for promoting research collaboration with those organizations. We report recent updates on RTRI's international activities below.

Overseas organizations with collaborative relationships



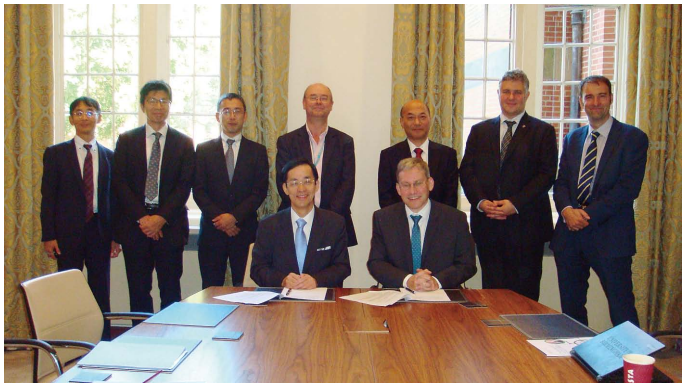
Cooperation agreement between BCRRE and RTRI

RTRI has signed a cooperation agreement for collaborative research with the Birmingham Centre for Railway Research and Education (BCRRE) at the University of Birmingham, UK in order to strengthen their relationship. Both parties will contribute to development of science and technology, in particular, railway technology through sharing their research capabilities and resources in advanced and practical research and development and in personnel exchange and development of the next-generation human resources under the agreement.

BCRRE has been dedicated to research and education on railway technologies. It covers research fields of vehicle aerodynamics, condition monitoring, train operation systems, weather disaster mitigation, geotechnical engineering, energy management, big data analysis, environment, and safety. Both organizations have already started exchanges of researchers.

Both parties will start the following two collaborative research projects under the agreement:

- Development of smart materials and reliability-based service-life assessment for railway concrete sleepers.
- Study on vehicle aerodynamics characteristics under crosswind.



Prof. Andy Schofield, Pro-Vice-Chancellor of the university and Dr. Norimichi Kumagai, President of RTRI at the signing ceremony.

Collaborative Research with SNCF

RTRI and French National Railways (SNCF) has implemented a number of joint research projects in various technical fields since two parties started research collaboration in 1995. Both parties have had collaborative research seminars every couple of years and the 7th one took place at RTRI, Tokyo, for three days from 11 to October 13, 2016.

In this seminar, the results of the 7th phase joint research projects were reported. In the research project "Inspection and predictive maintenance strategies for OCS," a new OCS state estimation method and an OCS configuration optimization method have been proposed. In the research project "Simulation models of ballasted track," SNCF and RTRI carried out DEM simulations of ballasted track behaviors.

In the R&D management meeting, RTRI and SNCF discussed on the application of Information and communication technologies to railways for further improving safety as well as for raising railway competitiveness by reducing overall operational cost. RTRI and SNCF also agreed to start 3 collaborative research projects including "Inspection and predictive maintenance strategies for OCS" and 6 information exchange projects including "high-precision train position detection technologies."

Ms. Carole Desnost, Chief Innovation Officer, Innovation & Research, SNCF and Dr. Norimichi Kumagai, President of RTRI at the management meeting.


RTRI


リアルタイム
スペクトラムアナライザ
表示アプリケーション


ISO/TC269 2nd
2013, Tokyo,
ISO