IK RAILWAY RESEARCH INSTITUTE (IK)

Advanced Rail Technologies

NEWSLETTER

July, August, September 2020, No. 22

ISSN 2449-6049

IN THIS ISSUE

Editor's

Andrzej Chudzikiewicz
Chairman of the Scientific Council IK

Dear Readers

The Scientific Council of the Railway Research Institute, at its first session in the new term of office on 15 July 2020, appointed me to the position of its Chairman. Expressing my gratitude for the trust placed in me, I would like to outline the tasks that the Council is to fulfil acting within the structure of the Railway Research Institute. As one of the Institute's bodies, it acts basing on the provisions of the Act of law on research institutes as well as the Scientific Council Regulations.

In compliance with provisions contained therein, the Scientific Council is the Institute's decision and opinion-making, initiating, and advisory body in the field of its statutory activities as well as in matters concerning the development of its scientific, research and technical staff. The Council performs multiple tasks, set out in the Law. I will not list all of them, however, I would like to highlight a few essential ones, i.e.:

- issuing opinions on the Institute's target thematic plans of research and development and financial projects as well as the Director's annual report of the tasks' accomplishment,
- approval of prospective directions of the scientific, development and implementation activities,
- initiating actions aimed at substantive and organizational development.

The Institute's position in the environment acting on the development of railways in Poland has been constantly increasing in recent years and I do believe it is not a short-term trend. The participation in numerous projects as well as the increasing number of expert opinions and research tasks clearly demonstrate this.

The Scientific Council will continue to support the Directors of the Institute in all such activities and cooperate in creating conditions necessary for the development of the staff, what should still ensure a high substantive level of conducted research projects.

andrzej.chudzikiewicz@pw.edu.pl

International Scientific Conference TRANSPORT MEANS

24th International Scientific Conference TRANSPORT MEANS 2020 was organized by Kaunas University of Technology in cooperation with Klaipeda University, IFToMM National Committee of Lithuania, Lithuanian Society of Automotive Engineers, The Division of Technical Sciences of Lithuanian Academy of Sciences, Vilnius Gediminas Technical University. For the first time, due to the COVID-19 pandemic in the world, the conference held on 30 September – 02 October, 2020 was organized as a virtual event.

The Railway Research Institute presented 3 lectures in the area of power engineering:

1. *Proposals for the use of renewable energy sources for traffic control devices power supply*: (Białoń, A., Kuznetsov, V., Hubskyi, P., Ostapchuk, O.)

The article presents a short analysis of the existing power supply systems in various kinds of command control and signalling devices used in Poland. The authors also analyzed the demand for electric energy necessary to power selected types of command control and signalling devices.

The possibilities of using various types of renewable energy sources to supply command control and signalling devices were presented. This article was prepared as part of a project co-financed by the Polish National Agency for Academic Exchange (NAWA).

2. *Modelling the quality of current collection under the conditions of a growing speed of rolling stock*: (Kaniewski, M., Kuznetsov, V., Hubskyi, P., Sychenko, V., Antonov, A.)

The use of high-speed electric rolling stock requires increased requirements for the reliability of its operation. Special attention should be drawn to the interaction of the overhead contact line (OCL) with current collectors. It is essential to develop tools for modelling the interaction between overhead contact line and current collectors. Nowadays, there is a need on some sections of the railways to increase the speed of trains and adjust the OCL construction to the speed of 250 km/h, which allows the infrastructure owner to obtain appropriate parameters for the dynamic cooperation of the overhead contact line with pantographs compliant to the TSI Energy requirements. In this presentation, the authors discussed the problem of equvalenting the contact line during simulation.

3. *Optimization of traction power supply system with variation of train flow sizes*: (Kuznetsov, V.G., Hubskyi, P.V., Sychenko, V.G., Kosarev, E.M., Papakhov, O., Bekh, P.)

Contemporary requirements for the electrified railways operation involve the effective use of available technical resources to ensure energy efficiency while increasing the train traffic volume intensity. The aim of the presentation is to justify the optimization of the DC power supply system with the variability of train flows and traction loads.

vkuznetsov@ikolej.pl

New Scientific Council of the Railway Research Institute

On 23 June 2020, there was hold election to choose members of the Railway Research Institute's (IK) Scientific Council who are either scientific or research-technical employees of the Institute. The following persons were elected to the IK Scientific Council:

- Renata Barcikowska, PhD,
- Witold Groll, MSc, Eng.,
- Krzysztof Ochociński, MSc, Eng.,
- Artur Rojek, PhD, Eng.,
- Lucyna Sokołowska, PhD, Eng.,
- Marek Sumiła, PhD, Eng.,
- Paweł Urbańczyk, PhD, Eng.

Moreover, pursuant to the Act of law, IK Prof. Jarosław Moczarski, Dr.Sc., Eng. and IK Prof. Andrzej Toruń, Dr.Sc., Eng. also joined the IK Scientific Council.

The newly elected members were nominated by the IK Deputy Director of Andrzej Massel, PhD, Eng. together with a representative the Ministry of Infrastructure, and also a member of the IK Scientific Council - Marcin Piwowarski, PhD.

Furthermore, the IK Scientific Council is composed of persons appointed by the IK supervising minister, i.e. the Minister of Infrastructure:

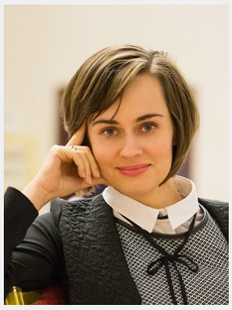
- Prof. Andrzej Chudzikiewicz, Dr.Sc., Eng. – Warsaw University of Technology, Warsaw,
- Prof. Mirosław Siergiejczyk, Dr.Sc., Eng. – Warsaw University of Technology, Warsaw,
- Prof. Adam Szeląg, Dr.Sc., Eng. – Warsaw University of Technology, Warsaw,
- Prof. PW Danuta Bryja, Dr.Sc., Eng. – Wrocław University of Science and Technology (PW), Wrocław,
- Prof. PK Andrzej Szarata, Dr.Sc., Eng. – Cracow University of Technology (PK), Cracow,
- Mirosław Antonowicz, PhD – the Organisation for Cooperation between Railways (OSJD) Warsaw,
- Marta Braun, PhD – Ministry of Funds and Regional Policy, Warsaw,
- Marcin Piwowarski, PhD –Ministry of Infrastructure, Warsaw,
- Paweł Podleśko, PhD – Ministry of Funds and Regional Policy, Warsaw.

At the first session of the newly elected Council on 15 July, 2020, Prof. Andrzej Chudzikiewicz, Dr.Sc., Eng. was elected Chairman of the IK Scientific Council, whereas Vice Chairmen are Marcin Piwowarski, PhD and IK Prof. Andrzej Toruń, Dr.Sc., Eng.

amarchela@ikolej.pl

IK to carry out the „HYPERNEX: IGNITION OF THE EUROPEAN HYPERLOOP ECOSYSTEM" project within H2020

Eliza Wawrzyn
Scientific Assistant, Railway Research Institute



The international project „HYPERNEX: Ignition of the European Hyperlooop ecosystem" has been approved by the European Commission and will be funded under the eighth framework program Horizon2020. The project won the open call of the Shift2Rail Joint Undertaking [1, 2].

HYPERNEX addresses the need for a catalyst to accelerate the development of the fifth means of transport, hyperloop, in Europe. A convergence of R&D entities, industry players, regulators and society needs to be aligned with hyperloop developers. While regulators and standardization bodies need to understand the operation and specification of the new transport mode, the industry and R&D ecosystem need a better understanding on how they can provide value to enhance hyperloop technical development. Therefore, HYPERNEX will cover the ignition of this work, bringing the relevant information into a monolithic asset, creating a ground of understanding among hyperloop developers and providing also the inertia to make the movement sustainable and durable in the coming years.

Participant No.*	Participant organisation name	Type	Country
1 (Co)	Universidad Politécnica de Madrid (UPM)	UNI	ES
2	HIT CERTH (CERTH)	RTO	EL
3	Hardt Hyperloop (HARDT)	SME	NL
4	Hyper Poland	SME	PL
5	IFS-RWTH Aachen University (RWTH)	UNI	DE
6	Instytut Kolejnictwa (IKOLEJ)	RTO	PL
7	University of Leeds (UNIVLEEDS)	UNI	UK
8	Sintef (SINTEF)	RTO	NO
9	TransPod France (TRP)	SME	FR
10	TU Berlin (Hermann-Föttinger Institut (TUB)	RTU	DE
11	Union Internationale des Chemins de Fer (UIC)	RTO	FR
12	Sapienza Università di Roma DICEA (DICEA)	UNI	IT
13	Zeleros Global, S.L. (ZEL)	SME	ES

Fig. 1. List of participants
Source: the author's own elaboration

To ensure the success of the project, HYPERNEX must cover a wide range of research and a critical mass of technical expertise in Hyperloop such as magnetism, electric propulsion, aerodynamics, electronics, sensors, industrial integration, transport economics and design among others to enable innovation across multiple application sectors. Therefore, the consortium consists of thirteen entities: both enterprises and research centers, whose expertise is not limited to technology products but also encompasses innovation and business development. A key factor of success in HYPERNEX is to have a broad geographic coverage in Europe both at the partners and their networks level (Fig.1 and Fig.2)

HYPERNEX will run for 1 year with the budget of EURO 250000. The project will focus on: hyperloop concept, existing infrastructures integration and competitiveness factors, hazard identification and safety case analysis, technical components of hyperloop architecture.

HYPERNEX consortium is organised to devote its complementary expertise to coordinate and execute a set of actions (hyperloop technology land value chain mapping, market and

Advisory Board		Project Supporters	
Altran	Hyperloop Transportation Technologies	Actisa	Norwegian Railway Directorate
AYESA	Renfe	Bane NOR	PTEC
U. Birminham	Sener	Foamrox	Railway Innovation Hub
EURNEX	TIS	Global Cloud Group	Ramboll
Virgin HyperloopONE	TUDelf	HyperNOR	Schneider electrc
Gesnaer	Univaq	Infraestructuras de Portugal	
EPFL	RTI		

Fig. 2. Commitment and support
Source: the author's own elaboration

stakeholder analysis, etc.) with the objective to produce an asset in a report. This report will serve as the backbone for a set of complementary actions that will maximize the impact of the work. The analysis and conclusions reached will be accompanied by the definition of a set of guidelines supporting its end-users on "how to interpret it", based on each stakeholder type (industry, academia, regulatory body, etc.). The relation model and concept methodology are depicted in Figure 3:

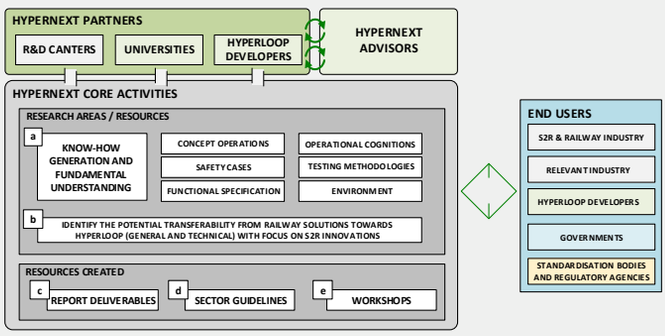


Fig. 3. HYPERNEX framework description
Source: the author's own elaboration

HYPERNEX project will bring a new common ground of understanding related to hyperloop in Europe. The complementarity of diverse profiles such as universities, R&D centres, Hyperloop developers, and industry players will grant the output of the project a great value for the acceleration of the hyperloop ecosystem. The aim is that the combination of deliverables and dissemination activities (including workshops) brought by HYPERNEX partners will set a starting point for the industry. Increasing the awareness of close industries such as Railway, Aerospace and others will bring synergies where all parties can benefit. The impact brought by HYPERNEX is aimed to be measurable and effective.

1. E. Wawrzyn „Shift2Rail – Investments in Innovations", Prace Naukowe Politechniki Warszawskiej, 2016, issue 111, pp 585-597
2. Council Regulation (EU) No 642/2014 of 16 June 2014 establishing the Shift2Rail Joint Undertaking.

ewawrzyn@ikolej.pl

Non-standard Test Methods for Pre-stressed Concrete Sleepers

Łukasz Antolik
Engineering and Technical Specialist, Materials and Structure Laboratory, Railway Research Institute

Tests of pre-stressed concrete and wooden sleepers used for the track construction have been carried out in the Materials and Structure Laboratory for many years. Routine test methods with respect to pre-stressed concrete sleepers are based on the Polish standard PN-EN 13230-2 and they are necessary to determine the operational strength of the product, established for several dozen years. On the other hand, the strength tests of finished products presented further in the article were performed in the range of forces exceeding the values possible to be obtained during operation.

The Railway Research Institute undertook the task of checking pre-stressed concrete sleepers in terms of resistance to exceptional and extreme loads, i.e. resulting from flat places on the wheel running surfaces or resulting from a rolling stock derailment.

Firstly, pre-stressed concrete sleepers were subjected to exceptional cyclic loads in order to determine the strength limit of the structure. For this purpose, a series of fatigue tests were performed, according to the diagram below.

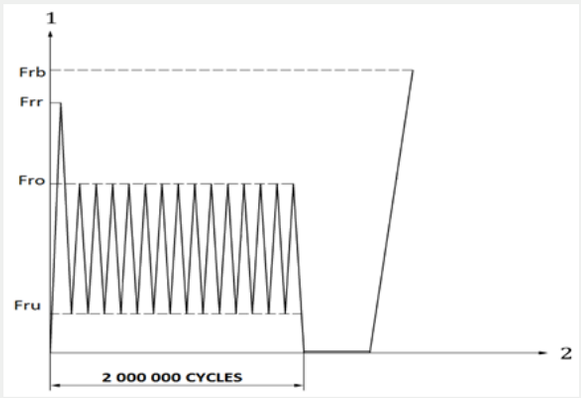


Fig. 1. Fatigue test diagram (*Source:* the author's own elaboration)

The standard Fr_u force was 50 kN and the Fr_o value was increased from the design value to 300 kN, which was twice the routine force applied. If 2 million load cycles through the sleeper, the force for the next test was increased in steps by another 20 kN in order to draw the curve of resistance to exceptional cyclic loads. In the case of untimely cracks of the sleeper, the test was repeated with the force reduced by 20 kN. An example of the obtained diagram of the correlation between the maximum force applied in the test and the number of cycles of loads transferred by the sleeper is shown in the diagram (Fig. 2). It should be stressed that the values of the crack width for the tested type of sleeper after a load of 2 million fatigue cycles with a force of 300 kN still met the requirements of PN-EN 13230-2. At the same time, no significant impact of the manufacturing technology on the extreme strength of the finished product was found.

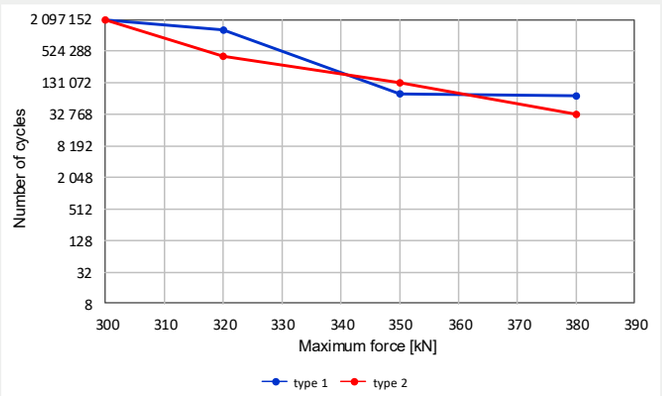


Fig. 2. Exemplary curve of resistance to exceptional loads
Source: the author's own elaboration

Another test performed was the simulation of rolling stock drive in a derailed state. During this test, the integrity of the structure after hitting the wheel flange, the degree of concrete damage, reinforcement and anchoring of the rail fastening elements were checked. For this purpose, a special pile driver was prepared to simulate the rim of the wheel running on the edge of the sleeper at a speed of up to 35 km/h. The elastic properties of the ballast were simulated using 6 mm thick elastomeric base plates placed under the sleeper. The 1300 kg pile driver is equipped with a foot in the shape of a rail wheel rim profile with a nominal diameter of 920 mm. The place of impact on the sleeper cross-section was set so as to simulate the falling of the wheel rim inside and outside the rail track. The diagram below (Fig. 3) shows the method of carrying out the dynamic test.

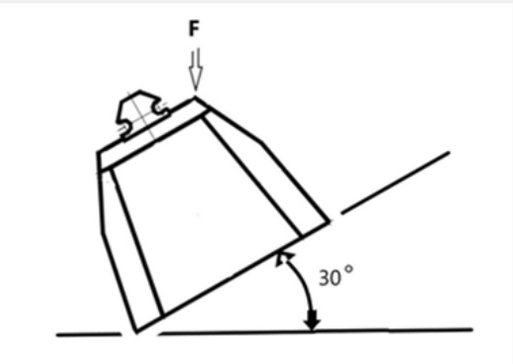


Fig. 3. Diagram of pile driver test (*Source:* the author's own elaboration)

As a result of the performed impact tests, effects similar to the damage sometimes observed in the track after derailment were obtained. In the analysed cases, the structure remained its integrity, but the place of impact as well as the degree of the track bed elasticity were of great importance.

The experimental tests presented in this article were a part of the tests of sleepers simulating exceptional and extreme loads, made as an extension of the standard tests carried out in accordance with PN-EN 13230-2.

lantolik@ikolej.pl

Verification of Railway Line E-65 Warszawa–Gdańsk–Gdynia Adaptation to the Speed of 200 km/h

Jerzy Cejmer
Engineering and Technical Specialist, Railway Track and Operation Department, Railway Research Institute

The aim of the study was to analyse the possibility to introduce the speed up to 200 km/h on selected sections of railway Line no. 9 on Warszawa Wschodnia – Gdańsk Główny section (from km 4.254 to km 328.100), and Line no. 202 on Gdańsk Główny – Gdynia Chylonia section (from km 0.000 to km 27.067), compliant with data implemented in ETCS as well as define activities which will allow the implementation of the above in technical, as well as organizational, formal and legal terms.

The study covered the analysis of rudimentary documentation for the operation of the railway line in terms of technical, formal and legal compliance of the solutions applied in the infrastructure, energy and control-command and signalling trackside subsystems, including the conditions of placing in service of devices and structures. Additional checks, calculations and tests were carried out, enabling the change of the existing or obtaining by PKP PLK S.A. new certificates of placing in service of types of structures and devices for speeds up to 200 km/h.

As a result of the verification of permanent way documentation (rails, fastening systems, sleepers, switch sleepers/bearers), it was found that in most cases there are no formal obstacles to operation at speeds above 160 km/h. Three types of structures were identified (2 types of pre-stressed concrete sleepers and one type of fastening system) that did not have certificates of placing into service of a type. Appropriate documentation has been prepared in order to enable obtaining this certification by the Office of Rail Transport.

The kinematic calculations prepared by the Ordering Party were verified. The analysis was aimed at checking whether the permissible values of geometric and kinematic parameters were not exceeded at the speeds assumed by the Ordering Party. The verification analysis confirmed that the kinematic calculations are correct and compliant with the applicable requirements, which may constitute the basis for the implementation of the designed speed profile on the Railway Line no. 9.

A geotechnical analysis of the track-beds was performed on the strengthened sections in order to assess the effectiveness of the solutions applied.

An analysis of the technical condition of all engineering objects located on the sections where the speed over 160 km/h will be increased was performed. The verification was carried out for 136 engineering structures.

The geometry of the catenary was verified. It was estimated that the overhead contact line on Line no. 9 allowed running at a speed of 200 km/h provided that the catenary was properly regulated.

The assessment of the efficiency of the electric traction power supply system was conducted on the basis of simulations and calculations of the mean useful voltage on the pantograph and the minimum voltage at the assumed traffic. It was concluded that the power supply system meets the performance interoperability requirements.

Trackside command-control and signalling devices such as control systems of switches, signals, signal gates, wheel sensors as well as support constructions were analysed.

The quality of the VHF 150 MHz railway radio communication network was verified. The necessary conditions to be met before making a decision to use this network for traffic at a speed of 200 km/h were described. The study of the quality of voice messages transmission through the VHF 150 MHz railway radio communication system showed that the intelligibility is at a satisfactory level. The operation of the Radio-stop system was positively verified.

The tests of dynamic interactions on track-side structures and devices and in the vehicle-track system, as well as dynamic tests of cooperation between the pantograph and the catenary were performed. The tests were carried out with the use of two test trains: the classic one with the EU64U4 locomotive (Photo 1) and the EMU ED250.

Photo 1. Test train for dynamic tests at Gdańsk Główny station
Source: the author's own elaboration

The results of tests and analyses in individual industries allow drawing the conclusion that the types of technical solutions used on the line allow the line to be operated at speeds of up to 200 km/h, provided that all structures and devices are in a proper condition when the speed of 200 km/h is introduced and maintaining it throughout the line operation at a speed above 160 km/h.

jcejmer@ikolej.pl

Intelligent video surveillance of containers

Patryk Wetoszka
Signalling and Telecommunication Laboratory, Railway Research Institute

The Railway Research Institute participates in many innovative and modern national and international projects. In cooperation with several institutions and commercial companies, whose activities cover various fields of science, modern and pioneering solutions for industry and technology are created. The Signalling and Telecommunication Laboratory takes part in many modern projects. Among them is a project called "Intelligent video surveillance of containers" POIR.04.01.04-00 -0157/17-00, financed by The National Centre for Research and Development selected under Measure 4.1 of the Operational Programme Intelligent Development 2014-2020.
The leader of the project is MobileMS company, while the Railway Research Institute in cooperation with other consortium members, i.e. Institute of Science and Technology STIPENDIUM, Kodegenix performs various types of research and development work. The main objective of the project is to develop a demonstration installation and to validate the technology leading to an innovative product with the IMW own name in the form of an intelligent monitoring system for railway wagons, which makes it possible due to:

- intelligent analysis of monitoring data, allowing for risk assessment and forecasting of service costs. It uses real-time data on the technical condition of freight wagons and related geolocation data, automatic monitoring of the fleet, automatic alarms, downtime, entry/departure to/from the zone, data analytics, accurate wagon mileage,
- detection of faults in freight wagons (flat surfaces, flat wheel, adhesives) through vibration diagnostics and a network of sensors (bearing temperature sensors, tanker gas pressure sensor) will reduce the costs associated with shunting and reloading of damaged wagon goods.

The development path for a network of intelligent sensors is designed to develop small, wireless, autonomous sensors for mass assembly on key elements of the wagon. R&D work on the power supply and construction of sensors for failure detection will allow achieving a state enabling maintenance-free operation of the sensors, i.e. appropriate mechanical and energetic durability eliminating the need for servicing and battery replacement for many years.

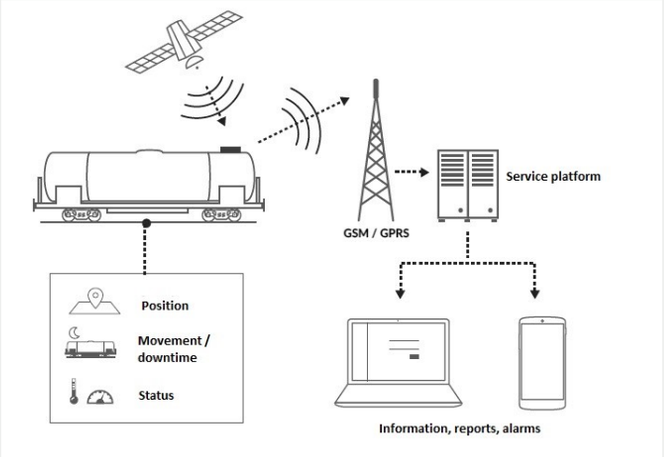


Fig. 1. System operation structure
Source: the author's own elaboration

The Railway Research Institute participates in research and development projects both at the stage of laboratory tests using accredited test stands and at the Experimental Test Track Operation Centre in Żmigród. The facility, which is nearly 8 km long, enables to carry out tests in conditions closest to the real intelligent container video monitoring system.

The possibility to carry out experimental studies at the Experimental Track Operation Centre in Żmigród allows for regular improvement of the IMW product in order to avoid unexpected system faults in the target operation. The infrastructure of the facility allows for conducting tests in extreme operating conditions.

Products created as a result of the project will allow obtaining unique functions of the whole solution, not available in the current solutions on the market.

pwetoszka@ikolej.pl

Eye Tracking Application in Tests in Rail Transport

Jakub Młyńczak
Adjunct, Railway Research Institute

Eye tracking - is a research method consisting in tracking the eyeballs movements with a device called an eye tracker. The most commonly used eye trackers are special glasses with a camera that tracks even a slight movement of the eyeball. It records it during explicit and implicit awareness.

By analyzing the movement of the eye, eye tracking allows determining information about the position of the eyeball at a given moment and to indicate the point of fixation (focus) of the eyesight. Thanks to the conducted research, we are able to determine how people react to a given object, what the recipient focuses on and what information remains unnoticed.

Eye tracking is applied, inter alia in ergonomics, marketing and advertising, medicine and psychology.

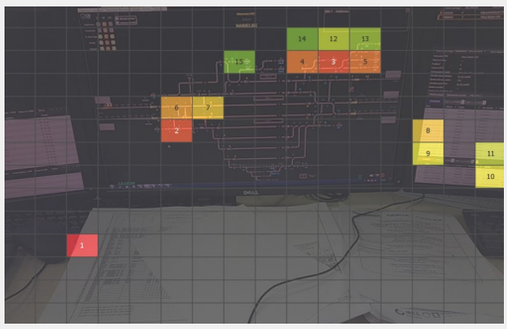
There is a possibility and need to apply eye tracking for tests in rail transport, e.g. ergonomics of computer control panels in command-control and signalling devices, ergonomics of driver's board in traction vehicles, assessment of the railway crossings technical condition and their surroundings. In addition to tests related to the assessment of ergonomics, the method can be used, for example, to test drivers and train traffic operators.

Fig. 1. System operation structure
Source: the author's own elaboration

Due to the compact size of the devices (Fig. 1), it is possible to carry out tests in real conditions, which is a very useful functionality of the method. It allows to assess how the devices are operated, and whether the elements on the control panels are properly arranged. In general, eye tracking allows viewing the surroundings through "other people's eyes". So far, tests related to the evaluation of the work of rail traffic operators have been successfully conducted, test drives with the drivers' participation have been carried out.

Figure 2a and 2b shows the maps of the fixation sequence (eyesight focus) of a long-serving rail traffic operator (upper picture) and a trainee (lower picture). It can be noticed that a person with less experience "wanders" on the screen looking for elements needed to carry out the command.

a)



b)

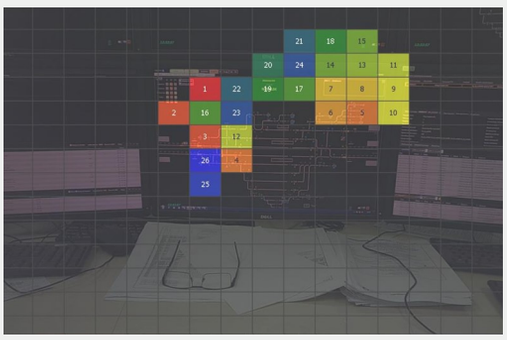


Fig. 2a and 2b. Maps of fixation sequence
Source: the author's own elaboration

Fig. 3. Areas of focus (interest)
Source: the author's own elaboration

Figure 3 shows an exemplary area of the driver's interest ahead of a level crossing. Instead of focusing on the signs, the driver observes the depot on the left side of the road.
The presented method is only being tested to assess issues related to rail transport. However, the first tests indicate its usefulness in many areas of interest.

A significant limitation of the method may be the cost of the devices and their sensitivity to weather conditions, which imposes the possibility of testing indoors and outdoors in good weather. Nevertheless, technology is moving ever more forward, constantly improving and miniaturizing devices, so the limitations will be less severe.

jmlynczak@ikolej.pl

A webinar „Design, Acquisition and Operation of Rolling Stock – a New Approach”

Piotr Chyliński
Technical and engineering specialist, Railway Track and Operation Department, Railway Research Institute

A webinar „Design, Acquisition and Operation of Rolling Stock – a New Approach” was held on 20 August 2020. It was organized by Gosporail Consortium composed of Leon Koźminski University, Railway Research Institute, Ministry of Infrastructure and Ministry of Development within a project “Innovative and Standardized Model of Development of Passenger Rolling Stock Purchase Innorail”.

The “Innorail” project is aimed to develop a standardized model of the rolling stock acquisition. Its outcome will support the process of the rolling stock ordering and production both for the railway operators and organizers who order the rolling stock and rolling stock manufacturers who participate in tenders. The project is co-financed by the National Centre for Research and Development within the GOSPOSTRATEG programme.

During the webinar there were presented the outcomes of research projects carried out within “Innorail” project whose goal is to deliver tools to facilitate the implementation of activities aiming at improving the rolling stock quality and functionality as well as optimization of purchase and operation costs. The following presentations were shown during the webinar:

1. „Innorail Project – Premises and Aims” prepared by the Ministry of Infrastructure.
2. „Risk Assessment and Threat Control in the Process of Procurement and Rolling Stock Production” prepared by the Railway Research Institute.
3. „Analysis of Demand for Passenger Rolling Stock” prepared by ZDG TOR as ordered by the Consortium.
4. „Financial Analysis of the Process of Rolling Stock Purchase Using LCC Methodology” prepared by Academic Association Cukrowa 8 as ordered by the Consortium.
5. „Influence of Information Acquired at Workshops on Innorail Project’s Final Conclusions” prepared by the Railway Research Institute.
6. „Recommendations of Legislative Changes in the Public Procurement Law whose Implementation into the National Legal System Can Contribute to Improve the Public Procurement Process” prepared by Leon Koźminski University.
7. „On the Track to Effective Purchase Processes – Factors Ensuring Success in Rolling Stock Purchase” prepared by Leon Koźminski University.

The presentations outlined current legal and economic frameworks of the rolling stock purchase process. The method to identify rolling stock operational costs using Life Cycle Cost Method since its production up to the end of its operation and its decommissioning was outlined. The conclusions from strategic workshops conducted by the Railway Research Institute on 4 February 2020 were presented to the webinar participants. The workshops were attended by representatives of railway operators and transport organizers who actively transferred their knowledge and experience relating both to the rolling stock acquisition and its further operation as well. Leon Koźminski University presented recommended legal solutions applied abroad which might improve rolling stock procurement and recommended way of the preparations and organization of rolling stock procurement process.

The webinar was held on MS Teams platform. It was attended by over 50 participants representing railway operators, transport organizers, the Office of Rail Transport (UTK) and Gosporail Consortium members.

MINISTERSTWO INFRASTRUKTURY
MINISTERSTWO ROZWOJU
Narodowe Centrum Badań i Rozwoju
IK INSTYTUT KOLEJNICTWA
AKADEMIA LEONA KOŹMIŃSKIEGO

pchylinski@ikolej.pl

Editors:

Dr Renata Barcikowska, Editor-in-chief
Agata Pomykała
Jolanta Olpińska
Małgorzata Ortel
Andrzej Szmigiel

Contact:

IK - Railway Research Institute
04-275 Warsaw, Poland
www.ikolej.pl
E-mail: ikolej@ikolej.pl