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From the Editor's Desk:

Faeze Ghofrani, Public Relations Officer INFORMS-RAS, Penn State



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The Railway Applications Section (RAS) of INFORMS brings industry experts, academic researchers, and OR/Analytics practitioners together to find creative solutions to meet the challenges facing the railroad industry. The RAS meetings at the INFORMS annual meeting play an important role in meeting RAS's objectives.

Thank you to all those who have helped with this year's conference. We encourage all of you to consider taking an active role in RAS next year by presenting at RAS webinars, chairing a session, presenting in a session, helping with the problem-solving competition, or helping with the student paper competition, etc. RAS is only as good as we make it.

We are already planning for INFORMS 2023 so if you are interested in getting involved, please don't hesitate to reach out by email (railwayapplicationssection@gmail.com) or via social media [Facebook](#), [LinkedIn](#). Some of the volunteering opportunities are chairing one of our competitions, formulate a problem and provide data for the problem-solving competition, chair the RAS cluster at the annual meeting, organize the roundtable or the interactive session, among others. Hope you stay safe and healthy during this holiday season.

Finally, we wish to express our sincere gratitude to our generous sponsors – Norfolk Southern Corporation, BNSF Railway, Wabtec Corporation, Optym, and TTX Company – whose contributions make many of the RAS functions possible. Thank you!

Wish you all a Happy 2023!!

Invited Article: New Tool for Evaluating Deployment of Alternative Energy Locomotives

C. Tyler Dick, Assistant Professor, Civil, Architectural and Environmental Engineering, The University of Texas at Austin

ctdick@utexas.edu

Each year, more than 25,000 locomotives are used to transport 1.7 billion tons of cargo across the United States. Rail freight is relatively efficient and clean, roughly four times less carbon intensive than moving freight by highway trucks. Freight rail accounts for only 2% of all transportation-related U.S. energy use and greenhouse gas (GHG) emissions, even though nearly 28% of all US freight transportation is moved by rail. Although freight railroad fuel efficiency has doubled since 1980, up to 472 revenue ton-miles per gallon in 2019, and locomotive manufacturers continue to improve locomotive emissions to meet tightened US Environmental Protection Agency standards, many freight rail operators have already committed to pursuing significant GHG emission reductions. Further efficiency gains and reductions in emissions required for the rail industry to meet sustainability and climate goals will likely require further refinements to the diesel combustion process or, to truly decarbonize, a shift to a different locomotive technology using alternative energy sources.

Switching from the standard mainline diesel-electric locomotives of today to cleaner options such as electric, battery electric, battery-diesel hybrid, and hydrogen fuel cell technologies can significantly decrease emissions if renewable sources of electricity and fuels are available. However, these systems will only work if they correctly match the right new propulsion, energy storage, and charging and fueling infrastructure technologies with the operational practices customized to support them. This presents the freight rail industry with many questions regarding which alternative energy locomotive technologies to develop, and how to deploy these locomotives to maximize the decarbonization returns on this substantial capital investment.

Researchers at the Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) are collaborating with leading industry and research partners, including the University of Illinois Urbana-Champaign (UIUC), University of Texas at Austin, BNSF Railway, and Southwest Research Institute, on a new modeling framework that can be used to analyze and plan deployment of net-zero-emissions locomotives and associated energy supply and fueling infrastructure. The Advanced Locomotive Technology and Rail Infrastructure Optimization System (ALTRIOS) software currently under development will offer an integrated package to optimize deployment of locomotive technologies, railway energy supply infrastructure, and train operating practices for cost-effective deep decarbonization of mainline freight rail operations. DOE's Advanced Research Projects Agency-Energy (ARPA-E) Lowering CO₂: Models to Optimize Train Infrastructure, Vehicles, and Energy Storage (LOCOMOTIVES) initiative is funding the ALTRIOS project.

The well-mapped set of fixed, high-density routes operated by the major freight railroads should make planning for deployment of alternative energy locomotives relatively straightforward. However, decarbonizing rail freight presents unique challenges in the form of requirements for propulsion power, locomotive range, and interoperability between railway operators. Any strategies for decreasing emissions and energy use will also need to factor in the wide geographic distribution of fuel and energy supply infrastructure, high capital costs, and the long lifespans of the locomotive fleet. ALTRIOS will address these complexities with a flexible open-source modeling framework that will help to assess the feasibility of using various energy storage and electrification technologies such as batteries and fuels cells in heavy-haul freight railways.

To meet industry research needs, ALTRIOS will evaluate and optimize efficient GHG emissions-reducing line-haul freight technology through simulations at the energy conversion and storage, locomotive, train, and corridor



levels. The single unified simulation model will combine locomotive powertrain and energy storage technology models with robust train dispatching and corridor simulations driven by a high-level train planning module.

As shown in the figure, users will provide ALTRIOS with the route topography and topology of a set of study corridors, freight traffic demand between origin-destination pairs on the study corridors, parameters of a locomotive fleet deployment scenario including the number of locomotives of each conventional and/or alternative energy type, and the location of fueling and energy supply infrastructure. The ALTRIOS train consist planning module will transform the freight traffic demand into a train plan that determines the type, length and weight of each train to depart from an origin terminal plus its assigned locomotive consist. The train plan is then passed to a meet/pass planner that uses deadlock-free dispatching logic to resolve train routing conflicts and develop a train path and target speed profile from origin to destination. The train paths are then subject to a high-fidelity train and locomotive powertrain simulation that determines the energy consumption and associated emissions of each train run. Economics models then evaluate the costs and GHG intensity of the train operations associated with the fleet deployment scenario. Users, or an optimization routine, can then adjust the locomotive deployment scenario to explore “what if” scenarios and determine the best set of locomotive technologies and deployment strategy to meet their business and climate objectives. ALTRIOS is currently being developed in the Rust and Python programming languages with a planned open-source release in spring 2023. For more information on ALTRIOS, please contact Tyler Dick at ctdick@utexas.edu.

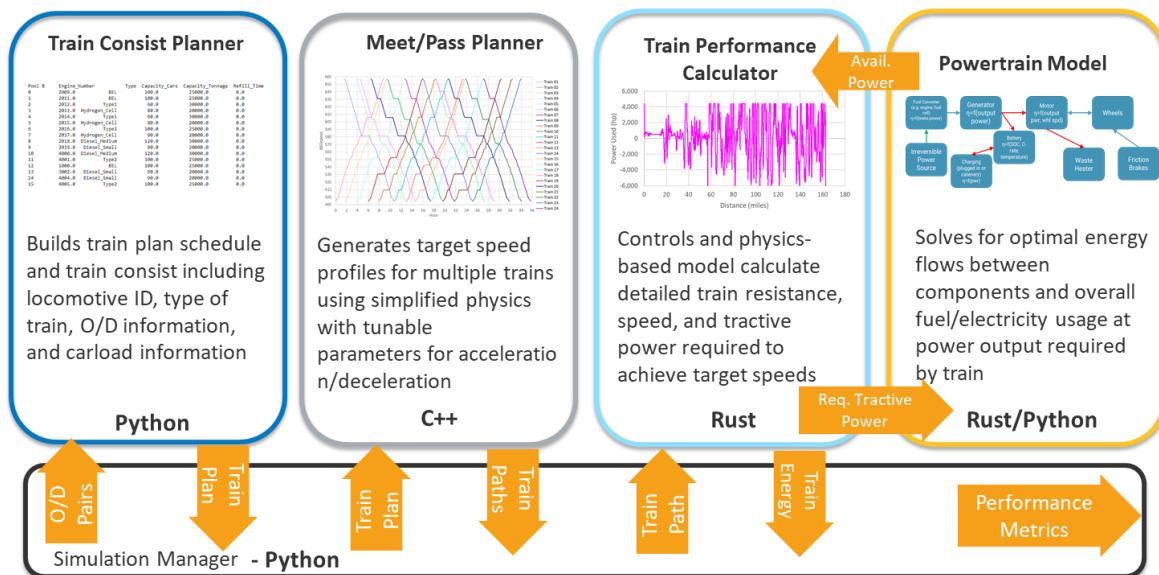


Figure 1: Core rail planning and operations simulation modules included in ALTRIOS

RAS Webinars Continued to be a success story in 2022!

During 2022, the RAS webinar series continued to be a success. Many thanks to the 2022 RAS webinars' organizers:

Andrea Arias, Sr. Operations Research Specialist, BNSF Railway (andrea.ariasllorenty@bnsf.com)

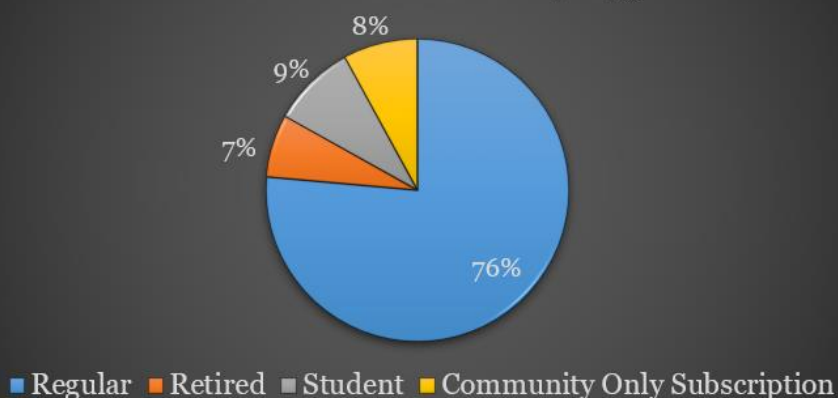
Nikola Bešinović, Chair of rail and public urban transport, TU Dresden (nikola.besinovic@tu-dresden.de)

If available, completed talks are posted on the [RAS YouTube](#) channel and the [RAS Website](#) for your viewing enjoyment. To join the organizing team, or to suggest topics or speakers, reach out to the organizing team.

RAS Member Profile 2022

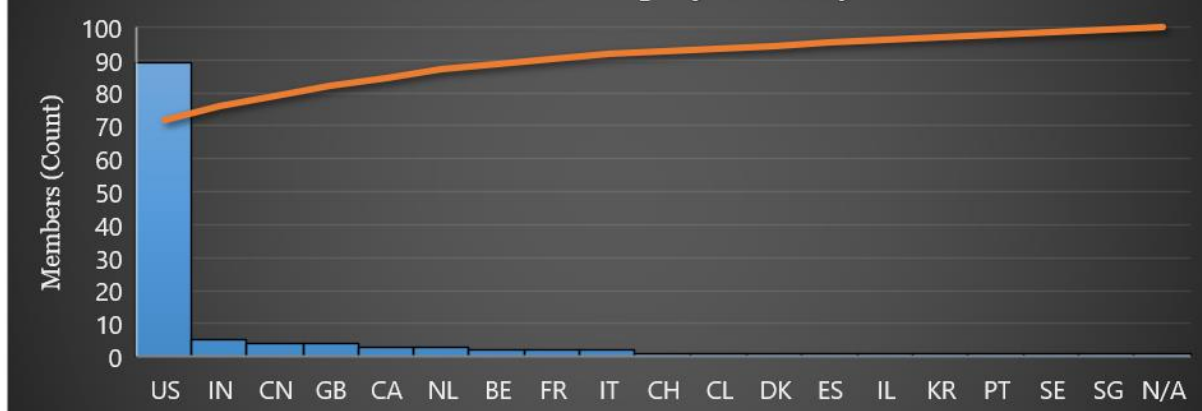
Faeze Ghofrani, Public Relations Officer

Distribution of Members by Type

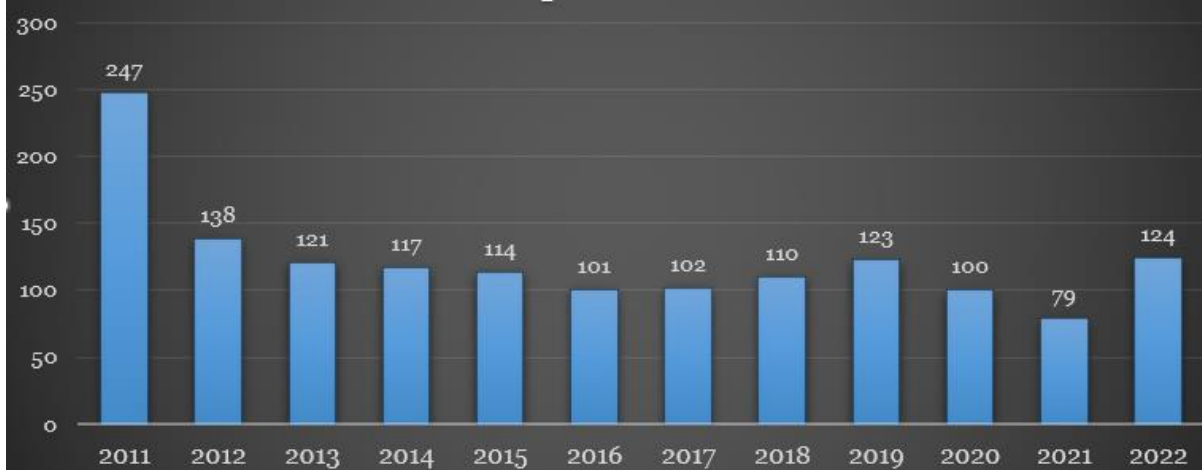


As of the end of 2022, the total number of RAS members was 124, which represents a 57% increase compared to 2021. 76% of the members are regular, 9% are students, 7% are retired and 8% are community-only members. Out of all members, 89 are from the USA, and the rest from at least 17 countries including: The Netherlands, Canada, China, France, India, among others.

RAS Membership by Country



RAS Membership Trend over Time



After two years, we had a successful in-person INFORMS 2022 meeting, which wouldn't have been possible without your support, so we deeply thank you for all your commitment and engagement to this wonderful community. We'd love to see you around next year so if you have not renewed your RAS membership, you can do it [here](#), and please also help us spread the word among your friends and colleagues so we can welcome more people to RAS. Good news is the dues have not changed (see table below) and are FREE for students and retired!!

Member Type	Regular	Student/Retired	Community-Only Regular	Community-Only Student
Dues (\$)	20	0	30	15

RAS Student Participation Scholarship

Faeze Ghofrani, Scholarship Committee Chair, Assistant Teaching Professor, Penn State

For the first time, RAS offered participation scholarships to eligible students to participate and present their work at INFORMS. The awarded scholarship was in the form of registration fee for participation at 2022 INFORMS Annual Meeting. The eligibility criteria included any RAS student member planning to present their railway-related work at the 2022 INFORMS.

Congratulations to the 2022 scholarship winning applicants/presenters:

- **Swastika Mishra**, Pursuing Bachelor degree in Mechanical Engineering, Netaji Subhas University of Technology, New Delhi.
Presentation Title: Conceptualizing Mindfulness in Solving Accident Relief Train Location Problems
- **MD Tabish Haque**, Pursuing PhD degree in Industrial & Management Engineering (IME), Indian Institute of Technology Kanpur, India.
Presentation Title: An Integrated Approach for Social Distancing and Revenue Optimization In Long Distance Passenger Trains

Session Schedule

Railway Applications Section Sponsored Sessions INFORMS Annual Meeting 2022, Indianapolis

Cluster Chair: Alexander Lovett (Union Pacific Railroad)

Cluster Co-chairs: Shuai Su (Beijing Jiaotong University) & Yanshuo Sun (FAMU-FSU College of Engineering)

Check out the presentations available [here!](#)

Sunday, October 16th 2022

RAS Student Paper Competition (Chairs: Stefano Rieppi, Norfolk Southern Railway and Andrea D'Ariano, Università degli Studi Roma Tre, University Park)

- **A MaxSAT Approach for Solving a New Dynamic Discretization Discovery Model for Train Rescheduling Problems**, Anna Livia Croella¹, Carlo Manino², Paolo Ventura³, Bjørnar Luteberget⁴, ¹Sapienza - University of Rome, Roma, Italy; ²University of Oslo, Oslo, Norway; ³Istituto di Analisi dei Sistemi ed Informatica (IASI) del CNR, Roma, Italy; ⁴SINTEF, Oslo, Norway.
- **On the Fragility of a Train Timetable**, Marta Leonina Tessitore¹, G. Sartor², M. Samà¹, C. Mannino², D. Pacciarelli¹, ¹Roma Tre University, Roma, Italy; ²SINTEF Digital, Oslo, Norway.
- **Operational Railway Crew Planning with Individual Sharing-sweet-and-sour Rules**, Bart van Rossum, Twan Dollevoer, Dennis Huisman, Erasmus University Rotterdam, Rotterdam, Netherlands.
- **Joint Rolling Stock Rotation Planning and Depot Deadhead Scheduling in Complicated Urban Rail Transit Lines**, Dian Wang¹, Andrea D'Ariano², Jun Zhao¹, Qiyuan Peng¹, ¹Southwest Jiaotong University, Chengdu, China; ²Roma Tre University, Rome, Italy.

RAS Problem Solving Competition (Chairs: Nikola Coviello, TrenoLab and Marc Meketton, Oliver Wyman, Princeton, NJ)

- **Real-time Traffic Management Based on a CDCR Approach - London's Elizabeth Line**, Cedric Steinbach, Hendrik Speh, Shanqing Chai, Arturo Crespo Materna, Technische Universität Darmstadt, Darmstadt, Germany.
- **A Hierarchical Decomposition Approach for Railway Disruption Recovery**, Akang Wang¹, Longfei Wang¹, Dong Zhang², Xiaodong Luo³, ¹Shenzhen Research Institute of Big Data, Shenzhen, China; ²Huawei, China; ³Chinese University of Hong Kong, Shenzhen Campus, Shenzhen, Guangdong province, China, China.
- **A Time-space Network-based Real-time Traffic Management Approach for an Urban Rail Transit System**, Zhenshan Xu, Xiaoming Xu, Jiancheng Long, Mingan Shen, Zijie Liu, Hefei University of Technology, Hefei, China.

Advanced Modeling Techniques to Urban Rail Operations (Chairs: Yanshuo Sun, Florida State University, Tallahassee, FL)

- **Estimating Rider Journey Variability Using Customer-facing WiFi Connection Data in Toronto, Canada**, Willem Klumpenhouwer, Amer Shalaby, University of Toronto, Toronto, ON, Canada. Contact: willem.klumpenhouwer@utoronto.ca
- **The Effect of a Skip-stop Policy on the Train Frequency of a Mass Transit Line**, Rodolphe Farrando¹, Nadir Farhi², Zoi Christoforou^{2,3}, Alain Urban⁴, ¹RATP, Université Gustave Eiffel, Paris, France,



PARIS, France; ²Université Gustave Eiffel, PARIS, France; ³University of Patras, Patras, Greece; ⁴RATP, PARIS, France. Contact: rodolphe.farrando@ratp.fr

- **Integrated Agent-based Modeling for Dynamic Operations in Urban Rail Transit Systems**, Bingyu Zhao¹, Yili Tang², ¹Vienna University of Technology, Vienna, Austria; ²University of Regina, Regina, SK, Canada. Contact: yili.tang@uregina.ca

Application of AI in Prediction and Train Operation of Railway Systems (Chairs: Jiateng Yin and Boyi Su, Beijing Jiaotong University, Beijing, China)

- **Resource-Directive Train Rescheduling with Cross-Layer Problem Decomposition**, Shuguang Zhan¹, S. C. Wong², Jiemin Xie³, Xuesong Zhou⁴, ¹Hefei University of Technology, Hefei, China; ²The University of Hong Kong, Hong Kong, China; ³Sun Yat-sen University, Guangzhou, China; ⁴Arizona State University, Tempe, AZ, Contact: shuguangzhan@hfut.edu.cn
- **A Deep Reinforcement Learning Approach for the Traffic Management of High-speed Railways: Comparison and Case Studies**, Jiateng Yin, Beijing Jiaotong University, Beijing, China.

Intermodal Rail and Yard Automation (Chairs: Vishal Badyal, BNSF, Jeremiah Dirnberger, Wabtec Freight, Jacksonville, FL)

- **Yard Automation Beyond Power Switches and Remote Control Locomotives**, Jeremiah Dirnberger, Wabtec Freight, Jacksonville, FL, Contact: jeremiah.dirnberger@wabtec.com
- **Intermodal Railcar Network Analysis Utilizing ML**, Muhannad H. Ramahi, TTX Company, Chicago, IL, Contact: muhannad.ramahi@ttx.com
- **Railcar Network Analysis Using GPS**, Joseph Melchioris, TTX

Monday, October 17th 2022

OR Operations and Simulations (Chair: V. Varadarajan, Norfolk Southern, Suwanee, GA)

- **Evaluating Peak Volume Recovery in Hump Yards with Anylogic Simulation**, Jiaxi Zhao¹, Tyler Dick², ¹University of Illinois at Urbana Champaign, Urbana, IL, ²U of Illinois at Urbana-Champaign, Urbana, IL, Contact: jiaxiz3@illinois.edu
- **Analytical Models on Yard Capacity**, V. Varadarajan, Norfolk Southern, Suwanee, GA
- **An Integrated Approach for Social Distancing and Revenue Optimization in Long Distance Passenger Trains**, MD Tabish Haque, Faiz Hamid, Indian Institute of Technology Kanpur, Kanpur, India. Contact: tabish@iitk.ac.in
- **Tools for Predicting Decarbonization Impacts for the Rail Freight Industry**, George F. List, NC State, Raleigh, NC

RAS Interactive Session (Chair: Clark Cheng, Norfolk Southern Corporation)

- **Improving Flat Switching Processes**, Roger William Baugher, TrAnalytics, LLC, Johns Creek, GA
- **Interactive Car Routing Tool**, Andy Yoon, Norfolk Southern Corporation, Suwanee, GA
- **Modeling Terminal Operations**, Roger William Baugher, TrAnalytics, LLC, Johns Creek, GA
- **Yard Planner**, Jeremiah Dirnberger, Wabtec, Jacksonville, FL
- **Rail Express**, Carl D. Van Dyke¹, Roger Baugher², ¹TransNetOpt, West Windsor, NJ, ²TrAnalytics, Johns Creek, GA
- **Advanced Locomotive Technology and Rail Infrastructure Optimization System (ALTRIOS)**, Tyler Dick, U of Illinois at Urbana-Champaign, Urbana, IL
- **Exhaust Vent Analysis (EVA)**, Bryan Gabric, Yasha Zeinali, BNSF, Ft. Worth, TX
- **Service Design Schedule Viewer**, Brandi Wood, Wabtec, Melbourne, FL



RAS Poster Session (Chair: Pengling Wang, Tongji University, China)

- **Tram Trajectory Optimization Incorporating Disjunctive Time Constraints from Traffic Lights**, Zhuang Xiao¹, Pengling Wang², Qingyuan Wang³, Pengfei Sun³, Xiaoyun Feng³, ¹Southwest Jiaotong University, Chengdu, China; ²Tongji University, Shanghai, China; ³Southwest Jiaotong University, Chengdu, China.
- **Macroscopic Modeling and Control of Reversible Tracks in Railway Delay Management During Partial Blockages**, Bowen Gao, Dongxiu Ou, Decun Dong, Yuqing Ji, Tongji University, Shanghai, China
- **Timetable Optimization for Sharing-Corridor Metro Lines under Virtual Coupling**, Jianhao Ge, Pengling Wang, Xiaofang Xiao, Tongji University, Shanghai, China.
- **Mixed Transport Strategy for Freight and Passenger Transportation in Metro Systems during Off-peak Hours**, Yutao Ye¹, Junhua Guo², Lixin Yan², ¹Tongji University, Shanghai, China; ²East China Jiaotong University, Shanghai, China.
- **A Human-computer Interaction-based Method for Line Plan Adjustment of China High-speed Railway**, Cheng Bai, Tongji University, Shanghai, China.
- **Real-Time Prediction of Employee Workload in Digital Railway Control Rooms**, Léon Sobrie¹, Marijn Verschelde², Bart Roets³, ¹Ghent University, Ghent, Belgium; ²IESEG School of Management, Lille, France; ³Infrabel, Brussels, Belgium. Contact: leon.sobrie@ugent.be
- **Remaining Useful Life Prediction of Railroad Components in Amtrak using Conditional Probability Survival Models**, Mamadou Seck, Amtrak, Washington
- **Analyzing Passenger and Train Conductor Feedback Data in Amtrak Railroad Operation Using Text Mining: Mechanical Issue Centric**, Subramanian Ramasamy, Amtrak, Railway Express Agency, Washington, DC
- **Preliminary Analysis on Implementing Optimal Replacement Policy Using the Estimated Remaining Useful Life Values for Amtrak Mechanical Components**, Keivan Ghoseiri, National Railroad Passenger Corporation (Amtrak), Clarksville, MD
- **Train Dwell Time Evaluation at High-Passenger-Volume Stations with a Reliability Perspective**, Natchaya Tortainchai, University College London, London, United Kingdom.
- **Train Delay Propagations: What Should Be Paid Attention to?**, Ping Huang, Shu Liu, Francesco Corman, ETH Zurich, Zurich, Switzerland.

Emerging Rail Technologies (Chair: Ken Kenjale, Wabtec Corp., Pittsburgh, PA)

- **Presenter: Stefano Rieppi**, Norfolk Southern Railway, Roswell, GA
- **Panelist: Rammohan Venugopal**, Wabtec, Norcross, GA
- **Panelist: Jason Kuehn**, Oliver Wyman, Princeton, NJ
- **Panelist: Andrew Straatveit**, Federal Railroad Administration, Herndon, VA

Optimization and Simulation in Railroads (Chair: Rajah Varadarajan)

- **Optimizing the Rollout of Alternative Propulsion Locomotives Using Full Corridor Simulation**, Geordie Roscoe¹, Tyler Dick², ¹University of Illinois Urbana-Champaign, Urbana, IL, ²U of Illinois at Urbana-Champaign, Urbana, IL, Contact: groscoe2@illinois.edu
- **Econometric Modeling and Railcar Demand**, Daniel Windle, Joseph Towers, Trinity Industries, Dallas, TX, Contact: daniel.windle@trin.net
- **Digital Signal Systems and Their Impact on Freight Traffic**, Steven Harrod, Technical University of Denmark, Glostrup, Denmark.
- **Analysis and Prediction of Freight Railroad Shipping Rates: Regression Versus Machine Learning**, Diwen Shi, University of Illinois Urbana-Champaign, Urbana, IL



Roger Baugher Named 2022 Distinguished member

Steve Tyber, Distinguished Member Award Committee Chair, Data Scientist, Wonder

It is my sincere pleasure to announce that Roger Baugher is the 2022 recipient of the Railway Applications Section's Distinguished Member Award! Mr. Baugher was one of the founding members of the newly created Railway Applications Section (RAS) in 1999. His academic and professional accomplishments, including his significant contributions to both RAS as well as the railway industry in general, have been nothing short of remarkable.



He received his B.S. in Civil Engineering from Case Western Reserve University before continuing his studies in Civil and Railroad Engineering under the renowned Dr. William Hay at the University of Illinois in Urbana-Champaign, culminating in a M.S. He also holds an MBA from Northwestern University in Transportation and Finance.

Mr. Baugher has over 35 years of experience in the industry, which includes holding multiple director/manager-level positions at four separate operating railroads. His experience spans service design

and analysis, equipment management, system analysis and design, line capacity analysis, and much more. While at Norfolk Southern Railway, Mr. Baugher developed and implemented a railcar routing system that enables the Transportation Department to analyze the routing plan, and then implement it quickly and efficiently, a tool that has been at the core of an expanding set of transportation systems. Currently, Mr. Baugher is the president of TrAnalytics, LLC, where he develops various operational analysis tools for railway applications.

Since its founding, Mr. Baugher has been a staunch supporter of RAS and has “always been a proponent of research on railway operations at universities, and a strong supporter of continued engagement between RAS, railway operations practitioners, and university programs in this area,” says Dr. C. Tyler Dick of the University of Texas at Austin. Aside from being a solid mentor to the next generation of railroad operations practitioners, Mr. Baugher is a regular presenter at the INFORMS Annual Meeting. Furthermore, he has authored/co-authored several papers and presentations on railroad operations and modeling and is a contributing author to multiple industry-related books, including Springer's *Handbook of Operations Research Applications at Railroads*.

Truly, this article does not do justice to the extensive contributions Roger Baugher has made to both RAS and the railway industry in general over his many years of service. His steadfast commitment to the safe and reliable movement of trains as well as commitment to imparting knowledge to a new generation of railroaders exemplifies what it means to be a member of RAS. Therefore, Mr. Baugher is truly deserving of this year's award.

Congratulations, Roger!!!



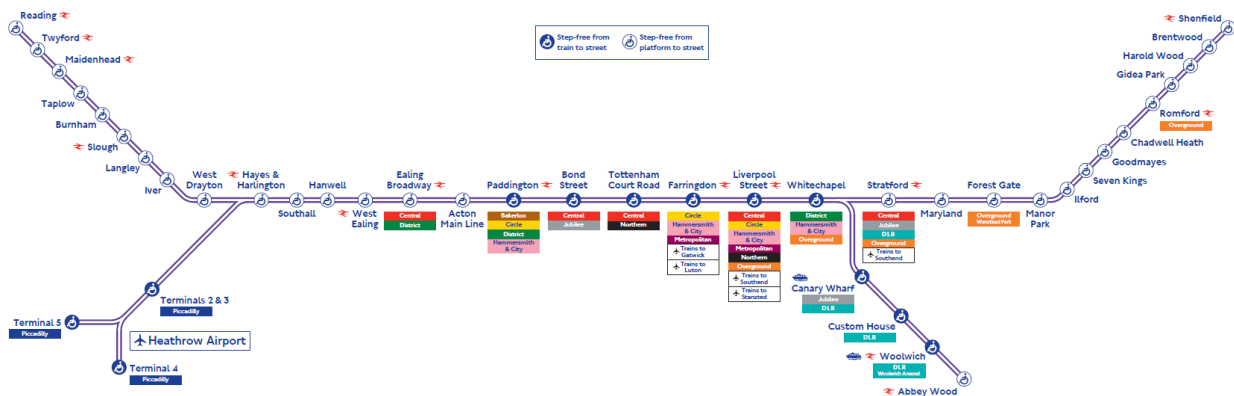
2022 Rail Problem Solving Competition

Designing real-time traffic management for an urban rail transit system: London's new Elizabeth line, UK

Marc Meketon, Oliver Wyman. Competition chair

Nicola Coviello, Trenolab. Competition co-chair and Problem Owner

The RAS Problem-Solving competition is designed to introduce participants to challenges in the railroad industry and its wealth of analytics problems with a total cash award of \$3,750. In this year's competition, participants were asked to design and develop a solution for real-time traffic management for the London's new Elizabeth line that would help them determine the optimal set of amendments for a given set of timetable disruption scenarios.



The London's new Elizabeth line

The judging criteria included both quantitative and qualitative components, such as: clarity of written research paper, solution approach, CPU time, solution quality and scalability. A total of 34 teams registered from all over the world, and 12 of them submitted final solutions. The winners of the 2022 RAS Problem Solving Competition are:

First prize

"Real-time Traffic Management Based on a CDCR Approach - London's Elizabeth Line" by Hendrik Speth, Shanqing Chai, Cedric Steinbach, and Arturo Crespo Materna; TU Darmstadt.

Abstract: The execution of scheduled railway operations is characterized by continuous monitoring and systematic adjustment of the existing schedule to the occurrence of stochastic events throughout the network. The adjustment of the schedule can be referred to as the "Conflict Detection & Conflict Resolution" (CDCR)



process. Due to the complexity of the CDCR process a series of decision-support tools mostly relying on heuristic methods have been developed to assist dispatchers in real-time. The central aim of this article is to develop a method to conduct a systematic adjustment of the scheduled railway operations to the occurrence of stochastic operational events. The method and resulting decision-support tool are to be implemented within the context of London's urban railway commuter system (i.e. Elizabeth Line). The proposed method is built over a heuristic CDCR Approach, which supports the comprehensive and traceable resolution of conflicts, making it particularly relevant as a decision-support tool. Such a framework would give decision-makers the flexibility to decide whether to systematically track the computational steps during the resolution of single conflicts or conduct the schedule adjustment process automatically.



Second prize



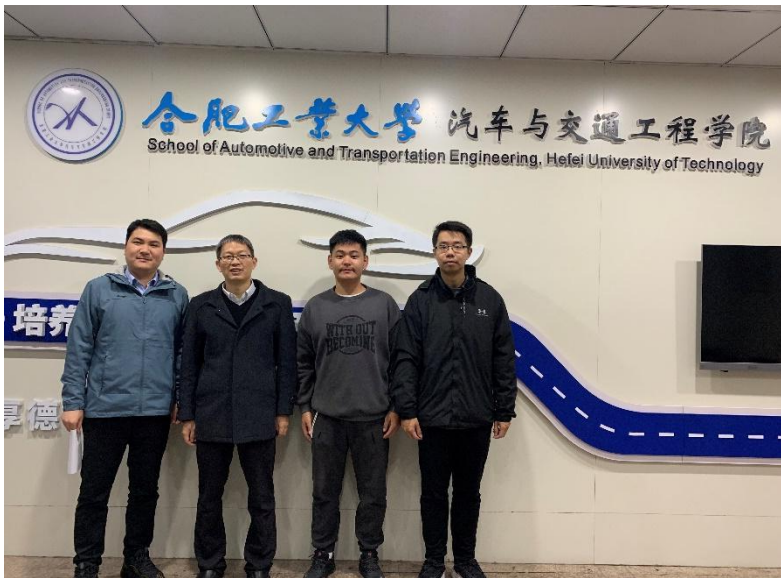
“A Hierarchical Decomposition Approach for Railway Disruption Recovery” by Longfei Wang¹, Shengcheng Shao², Dong Zhang², Akang Wang¹, and Xiaodong Luo^{1,3}; ¹Shenzhen Research Institute of Big Data, ²Huawei, ³The Chinese University of Hong Kong.

Abstract: This is a preliminary report on solving the daily railway disruption recovery problem for the 2022 RAS Problem Solving Competition. We present a novel decomposition approach that splits decision-making into three hierarchical and overlapping stages called rerouting, retiming, and repairing respectively. The computational studies on public benchmarks demonstrate the effectiveness and efficiency of our proposed approach.

Third prize

“A Time-Space Network-Based Real-Time Traffic Management Approach for An Urban Rail Transit System” by Zhenshan Xu, Xiaoming Xu, Jiancheng Long, Mingan Sheng, and Zijie Liu; Hefei University of Technology.





Abstract: Timetable disruptions in an urban rail transit system ultimately result in a loss of service quality for passengers. To minimize the loss, the operator would reschedule the train timetable and rolling stock duty accordingly. However, this rescheduling work is usually complex, especially in a densely system, for operators to determine manually and needs computerized tools to help them generate amendments. To cope with this complex task, we develop a time-space network-based traffic management approach, in which the underlying network has two layers. The first layer is constructed for the timetable rescheduling problem, based on which the problem is formulated using an integer program, and solved by a developed Lagrangian relaxation-based heuristic. We then decompose the rolling stock duty into several smaller duties in case this duty is no longer suitable for the obtained amended train timetable. Based on the newly generated duties, we construct the second layer for the rolling rescheduling problem and develop a greedy heuristic to assign rolling stock duties to train sets. We test our approach on London's new Elizabeth line. The results show that our approach can obtain a feasible amendment in 3-6 minutes on a personal computer for different timetable disruption scenarios, which confirms the effectiveness and efficiency of the proposed approach.

A big thank you to everyone who contributed to make this competition possible, and congratulations to the winners!!!



2022 INFORMS Railway Application Section (RAS) Student Paper Competition

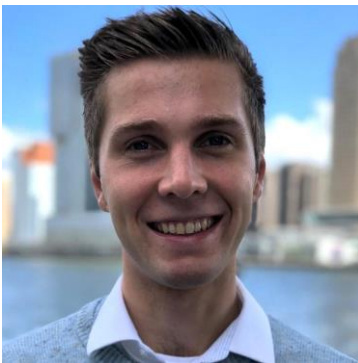
Andrea D'Ariano; Roma Tre University, Italy, Academic Competition Chair

Stefano Rieppi; Norfolk Southern Corporation, USA, Industry Competition Chair

After a careful 3-month assessment process, we have selected 4 outstanding winning papers of this year's Student Paper Contest. The final decisions have been made together with the continuous support of RAS Vice-Chair Nikola Bešinović (TU Dresden, Germany) and RAS Chair Andrea Arias (BNSF Railway, USA). In 2022, 24 eligible papers were submitted to this contest. These papers were evaluated based on the following criteria: practical relevance of the problem, ability to explain the problem, methodology and results in terms relevant and understandable to practitioners, advancement of the state-of-the-art, methodological contribution, theoretical contribution, significance of the case study, potential impact of the results, general comments on the paper (to justify the given scores). All papers received at least three double-blind evaluations. Overall, judges were positive about the potential theoretical and practical value of most of these papers, which are dealing with interesting, relevant and diverse railway operations research topics.

The INFORMS Railway Applications Section is very grateful for the strong commitment of the 27 judges: Paola Pellegrini and Joaquin Rodriguez (Université Gustave Eiffel, France), Jiateng Yin, Yihui Wang and Shukai Li (BJTU, China), Bisheng He (SWJU, China), Marcella Samà (Roma Tre U, Italy), Twan Dollevoet (Erasmus U, The Netherlands), Valentina Cacchiani (U of Bologna, Italy), Luis Cadarso (RJC, Spain), Christian Liebchen (ZU, Germany), Marco Pranzo (U of Siena, Italy), Sundaravalli Narayanaswami (IIMA, India), Saeid Saidi (U of Calgary, Canada), Pascal Kerschke, Nikola Bešinović and Joern Schoenberger (TU Dresden, Germany), Taku Fujiyama (UCL, UK), Edward Lin, Yudi Pranoto and Clark Cheng (NSC, USA), Gabor Maroti (VUA, The Netherlands), Yanshuo Sun (FAMU-FSU, USA), Valerio De Martinis (ZHAW, Switzerland), Xuesong Zhou (ASU, USA), Giovanni Luca Giacco (Trenitalia, Italy), Jacob Trepát (ETH Zurich, Switzerland).

The winners of the 2022 Railway Applications Section Student Paper Award are:



First Prize: Bart Van Rossum, Erasmus University Rotterdam “*Operational Railway Crew Planning with Individual Sharing-Sweet-and-Sour Rules*”

Advisors: Twan Dollevoet, and Dennis Huisman

Bart van Rossum holds a double Bachelor's degree in Econometrics and Economics and a Master's degree in Econometrics and Operations Research with a specialization in Operations Research and Quantitative Logistics. These degrees were obtained at Erasmus University Rotterdam, where Bart started as a PhD candidate at the Econometric Institute in 2020. In his research project *Integrated Railway Planning* Bart studies the railway crew planning process, with the goal of improving efficiency, reliability, and employee well-being. He develops large-scale optimization algorithms to tackle the problems arising in this setting. The project features a strong collaboration with Netherlands Railways, the largest passenger railway operator of the Netherlands.





Second Prize: Dian Wang, Southwest Jiaotong University, “Joint rolling stock rotation planning and depot deadhead scheduling in complicated urban rail transit lines”

Advisors: Andrea D’Ariano, Jun Zhao, and Qiyuan Peng

Mr. Dian Wang received his B.S. degree in Transportation and his Ph.D. degree in Transportation Planning and Management from the Southwest Jiaotong University, Chengdu, China, in June 2015 and in September 2022, respectively. In 2020, he was a two-year guest researcher at the Roma Tre University (virtually owing to covid-19) under the supervision of Prof. Andrea D’Ariano. His current research interests include the train timetabling and rolling stock scheduling in rail systems, as well as the optimization of districting problem and its applications to railway operations.



Third Prize: Marta Leonina Tessitore, Roma Tre University, “On the fragility of a train timetable”

Advisors: Giorgio Sartor, Marcella Samà, Carlo Mannino, and Dario Pacciarelli

Marta L. Tessitore is a PhD Student in Computer Science and Automation at Roma Tre University. She started her PhD in November 2019, when she joined the Automation and Operation Research in Industry (AUT.OR.I.) Group at the Engineering Department of Roma Tre University. In 2019, she obtained a MSc in Automation and Management Engineering at Roma Tre University, where she also received a BSc in Computer Science Engineering in 2016. In 2022, she spent 6-months as a visiting PhD student in Operation Research at SINTEF Digital, Oslo (Norway). Her research mainly focuses on developing models and algorithms aimed at solving scheduling and routing problems, with specific regard to railway applications.



Honorable Mention: Anna Livia Croella, Sapienza University of Rome, “A MaxSAT approach for solving a new Dynamic Discretization Discovery model for train rescheduling problems”

Advisors: Bjørnar Luteberget, Carlo Mannino, and Paolo Ventura

Anna Livia Croella is a Postdoctoral Researcher in Operations Research at La Sapienza University of Rome, where she earned her PhD in Operations Research (MAT-09) in May 2022 and graduated in Management Engineering in October 2017. She belongs to the Department of Computer Engineering, Automation and Management Antonio Ruberti (DIAG, formerly Department of Computer and Systems Engineering) at the Faculty of Information Engineering, Informatics and Statistics of Sapienza University of Rome. In April 2018 received a post degree recognition prize as one of the 400 outstanding students of Sapienza University of Rome. She is one of the four finalist of AIROYoung Best Thesis 2022. She is interested in Combinatorial Optimization, Mixed Integer Programming, Train Dispatching, Job Shop Scheduling, Waste Management

Congratulations to the winners!! The first three winners will receive a cash award of \$1,000, first place, \$500, second place, and \$250, third place; while the fourth winner will receive an honorable mention. The slides and recordings from their presentations at INFORMS 2022 can be found on the INFORMS RAS Website.



Industry News: BNSF to Build New Integrated Rail Complex in Barstow to Increase Supply Chain Efficiency Nationwide

From [*BNSF Railway Media News*](#)

BNSF Railway has announced plans to invest more than \$1.5 billion to construct a state-of-the-art master-planned rail facility in Southern California – and the first being developed by a Class 1 railroad.



The Barstow International Gateway will be an approximately 4,500-acre new integrated rail facility on the west side of Barstow, consisting of a rail yard, intermodal facility and warehouses for transloading freight from international containers to domestic containers. The facility will allow the direct transfer of containers from ships at the Ports of Los Angeles and Long Beach to trains for transport through the Alameda Corridor onto the BNSF mainline up to Barstow. Once the containers reach the Barstow International Gateway, they will be processed at the facility using clean-energy powered cargo-handling equipment, and then staged and built into trains moving east via BNSF's network across the nation. Westbound freight will similarly be processed at the facility to more efficiently bring trains to the ports and other California terminals.

"By allowing for more efficient transfer of cargo directly between ships and rail, the Barstow International Gateway will maximize rail and distribution efficiency regionally and across the U.S. supply chain and reduce truck traffic and freeway congestion in the Los Angeles Basin and the Inland Empire," said Katie Farmer, President and CEO of BNSF. "This will play a critical role in improving fluidity throughout our rail network, moving containers off the ports quicker, and facilitating improved efficiency at our existing intermodal hubs, including those in the Midwest and Texas. The facility will also have an important positive economic impact, including the creation of new, local railroad jobs," said Farmer.

"The significance of BNSF's investment to improve the supply chain here in California cannot be overstated. Rail plays a critical role in moving goods safely and efficiently, while reducing emissions due to congestion in many of our high-traffic corridors," said Trelynd Bradley, Deputy Director of Sustainable Freight and Supply Chain Development at the Governor's Office of Business and Economic Development. He added, "Projects like BNSF's will work to strengthen our inland local economies, such as that of Barstow in San Bernardino County. We look forward to continuing to work with projects like these, as well as others, to drive transformative investments that will enhance and elevate California's supply chain ecosystem for a more efficient and resilient tomorrow."



“BNSF’s planned Barstow International Gateway will improve cargo velocity through our port and reduce truck traffic on our freeways,” said Port of Los Angeles Executive Director Gene Seroka. “This project will help ensure that goods moving through the San Pedro Bay will get to consumers, businesses and manufacturers with speed and reliability.”

“The Port of Long Beach welcomes BNSF’s planned Barstow International Gateway in the high desert. This project will help improve supply chain fluidity, reduce environmental impacts and enhance the competitiveness of California and the nation’s largest port complex,” said Mario Cordero, Port of Long Beach Executive Director. Dawn Rowe, San Bernardino County Supervisor for the Third District, added, “The County of San Bernardino plays a critical role in supporting the movement of goods to the rest of the country. Barstow International Gateway will be essential for modeling new and efficient ways to address supply chain issues that have impacted everyone over the past several years.”

Willie A. Hopkins, Jr., Barstow City Manager emphasized, “This facility will bring thousands of jobs to Barstow, while increasing equity, opportunity and the economic competitiveness of the high desert.” He continued, “BNSF has been an important part of our city since its inception and on this 75th anniversary, we are proud to partner with them to ensure our success in the future.”

“We appreciate the support from leaders at the state, regional and city level and look forward to building on our 140-year history in the High Desert to open the Barstow International Gateway as soon as possible,” affirmed BNSF’s Farmer.

For more details please click [here](#)!



Letter from Incoming Chair Nikola Benisovic

Dear RAS members and friends,

First, thank you all for your wonderful support and involvement in the INFORMS Railway Applications Section. It has been great to have the opportunity to meet in person at the 2022 Annual Meeting after a long break and solely online events. A huge amount of effort goes into coordinating all of the events that occur before, during, and after the INFORMS Annual Meeting, and I would like to thank everyone that was involved in the planning.

I would like to particularly thank the outgoing 2021 RAS officers Andrea Arias (BNSF), Jay Baillargeon (FRA), Rajan Varadarajan, (Norfolk Southern) and Faeze Ghofrani (Penn State), student officer Saharnaz Nazari, (Penn State) as well as Cluster chairs Alexander Lovett (Union Pacific), Shuai Su (Beijing Jiaotong University) and Yanshuo Sun (FAMU-FSU, USA). It has been a great joy to work with you, and it is amazing what we have accomplished.

We thank Marc Meketon and Nicola Coviello for chairing the problem solving competition. We are also grateful to Girorgio Medeossi and the complete TrenoLab team, supported by MTR, for providing a challenging problem on real-time traffic management. We thank Andrea D'Ariano (Roma Tre University) and Stefano Rieppi (Norfolk Southern) for leading the student paper competition. We had record breaking 24 submitted high quality papers. The 2022 Poster session was organized by Pengling Wang (Tongji University) and featured awards for Best Student Poster. This year we initiated the RAS Participation Scholarship Program to support bright young researchers presenting their research at INFORMS Annual Meeting. Congratulations to all the winners!

We also thank Ken Kenjale (Wabtec) for organizing this year's executive roundtable. We are happy to have great speakers including Stefano Rieppi (Norfolk Southern), Jason Kuehn (Oliver Wyman), Ram Venugopal (Wabtec) and Andrew Straatveit (FRA). Finally, we continued organizing RAS webinars with inspiring talks from the US, Asia and Europe.

Looking Ahead: After a tough period, due to covid behind us, and seeing the rail industry continues to evolve, we focus toward more data-driven solutions. Thus, RAS will maintain its focus on providing timely and relevant activities and networking opportunities. We hope to strengthen relations between industries and universities around the world, and provide a platform for addressing their current and future challenges. We will work towards establishing closer relations with other sections and societies within INFORMS and wider, to increase the opportunities for our members. We will continue with organising RAS webinars providing new topics and contents to our existing and new members. I am excited to be a part of this great organization and I look forward to serving you all as chair in 2023!

Nikola Bešinović

Chair of Rail and Public Urban Transport, "Friedrich List" Faculty of Transport and Traffic Sciences

Technical University of Dresden

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Meet the 2023 RAS Officers

Chair: Nikola Bešinović

Nikola Bešinović is a Head of the Chair of Rail and Public Urban Transport, “Friedrich List” Faculty of Transport and traffic Sciences, Technical University of Dresden, Germany. His research develops optimization and analytics methodologies to promote efficient, reliable, and sustainable transportation systems. His focus is on railway traffic management systems, where he proposes data-driven decision-making approaches to enhance railway operations, train scheduling and driver behaviour. He is interested in new resilient transportation concepts, determining critical infrastructure, and impacts of increased transport demand on further technological development of railway systems. Nikola received several scientific awards, including the Young Railway Operations Researcher Award from IAROR, TRAVISIONS Young Researcher Competition, and the 3rd IEEE ITS Best Dissertation Award.



Vice Chair: Shuai Su

Bio/Position Statement: Dr. Shuai Su graduated from Beijing Jiaotong University and now serves as a professor at BJTU in China. He is the vice director of the Frontiers Science Center for Smart High-speed Railway System, vice director of the Key Laboratory of Railway Industry in Autonomous Train Control, and a regular member of the Transportation Research Board. His research focuses on the application of AI and big data technology in train operation control and optimization in railway.



Dr. Shuai Su carried out research on the pain points and frontier problems of the rail transit industry, which has promoted and supported the systematic and delicacy management and control of train operations. The achievements of energy-efficient train operation and intelligent train dispatching have been widely recognized by researchers. He published over 60 papers (including 25 SCI papers) as the first or corresponding author, of which 9 papers were published on IEEE Transactions or Transportation Research Part and 3 papers are ESI highly cited paper. The research achievements of train energy-efficient operation have been demonstrated and applied in Yizhuang Line, Changping Line and Line 7 of Beijing Metro. The research achievements have also been applied in 17 lines in Beijing, Shenzhen, etc., and promoted in Edinburgh, UK. Moreover, the engineering test of high-speed train energy-efficient operation technology has been carried out in the first automatic driving control test line of high-speed railway (Beijing-Shenyang Line). Dr. Su served as a RAS Cluster co-chair several times in the past years.

Treasurer: Jay Baillargeon

Bio/Position Statement: Mr. Jay Baillargeon is a Program Manager for the Federal Railroad Administration’s Office of Research, Development, and Technology and is based at the FRA’s Transportation Technology Center in Pueblo, Colorado. He leads a research program focused on the enhancement of railroad safety through innovative analytical strategies, including artificial intelligence applications for track-related datasets. Jay currently serves on multiple inter-agency task forces related to data management and artificial intelligence at the U.S. Department of Transportation (DOT), including the DOT’s AI Task Force in response to the Presidential Executive Order on AI. He has more than ten years of experience working in the railway industry and holds a Bachelor of Science in Mathematics and a Master of Science in Industrial and Systems Engineering. He has



been a member of the INFORMS Railway Applications Section for the last three years and, during the 2020 organizational year, served as the Problem-Solving Competition Chair. He previously served in the position of Secretary for the 2021 and 2022 organizational years as well. In addition to INFORMS, he is also a member of the American Railway Engineering and Maintenance-of-Way Association (AREMA) and the Institute of Industrial and Systems Engineers (IISE).

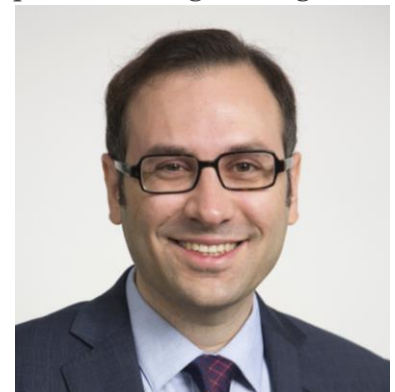
Secretary: Faeze Ghofrani

Bio/Position Statement: Faeze Ghofrani is currently an Assistant Teaching Professor of Rail Transportation Engineering at Pennsylvania State University). She holds a PhD in Civil Engineering from State University of New York at Buffalo. She has over seven years of research experience in railroad transportation Engineering. Her research vision is to incorporate recent data analytics advances and technologies into a broad range of railroad engineering problems. She has been an active member of INFORMS Railway Application Session (RAS) since 2018. Faeze was a RAS student officer in 2019, she served as the organizers of the RAS Student Paper Competition and RAS “Railroad Maintenance” session chair in 2021 and in 2022 she was the RAS public relations officer.



Public Relations Officer: Saeid Saidi

Bio/Position Statement: Saeid Saidi is an assistant professor in Transportation Engineering at the Department of Civil Engineering, University of Calgary, Canada since 2019. Prior to joining University of Calgary, he was a Postdoctoral Associate at the MIT Transit Lab between 2017-2019. Saeid’s research focuses on mathematical modeling and data analytics in transportation systems to create actionable intelligence for cities and transit agencies. His PhD research was on urban rail transit network optimization, and he has been working on the area of rail transit operations during his Postdoctoral and Assistant Professor appointments. He has worked closely with several transit agencies namely, Calgary Transit, Massachusetts Bay Transportation Authority, and Tehran Metro. These collaborations have led to several peer-reviewed journal and conference publications. He has developed research projects embracing new technologies and methodologies to address the current challenges in the industry. He has held several major research grants in the area of public transportation namely the Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant on “Urban Transit System Diagnosis, Monitoring, and Management Using Mobility Sensing Data” (PI, 2020-2025) and NSERC Alliance on “Transit Service Improvements to Cope with COVID-19” (co-PI, 2020-2021).



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