Title

Editorial: Safety and performance on the railways: Selected papers from the 7th International Rail Human Factors Conference

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Introduction

The railways are a fundamental part of our society, which, for approaching 200 years, have offered an essential means to move people and goods. The continued success of the railways is vital to providing a low-carbon form of mobility, and as a means of mass transportation within and between our increasingly urbanised centres of population.

Safety is paramount to the railways, be that the people who work to build, operate and maintain the rail service, passengers travelling on trains, or the public who live and work in and around the railways. Understanding performance is also key to delivering punctual, cost-effective railways that is resilient to disruption, particularly the impact of climate change on rail infrastructure. And, like many sectors, the railway is undergoing a digital revolution, with greater levels of data, automation and intelligence leading to centralisation and business change across all railway functions. The railways is therefore an exemplar of a complex socio-technical system where people and processes work together with engineering and technology to deliver system goals. Human factors and ergonomics has emerged as a key enabler of the modern railway, with contributions to all aspects of its functioning, and to passenger experience. The rail human factors community spans the industrial supply chain, operators, specialist consultants, academics, and a range of regulatory and oversight bodies. Together these stakeholders work to deliver new knowledge and methods, helping understand and support the role of people within the railway system.

One forum where the rail human factors community shares ideas and knowledge is the International Rail Human Factors Conference. This Special Issue marks the seventh edition of the conference, comprising a selection of papers presented at the conference in June 2021. The aim of this

conference was to bring together scientists, consultants, regulators, operators, infrastructure managers, manufacturers and suppliers to share rail human factors knowledge. The conference focus was on the discussion of topical issues such as in-cab signalling, traffic management, non-technical skills, the platform-train interface and safety culture. The papers in this special issue are enhanced peer-reviewed versions of a selection of key papers from the conference, covering a range of applications, as well as the development and implementation of theory and methods, that has relevance to both the rail human factors community, and to the wider discipline of human factors / ergonomics.

History of the conference

The conference series began in 2003 with the first event held in York, UK, and documented in the 2005 book Railway Human Factors: Supporting the Integrated Railway edited by John Wilson, Beverley Norris, Theresa Clarke and Ann Mills (Wilson et al., 2005). The most recent iteration, on which this special issue is based, took place online in June 2021. The inception and development of the conference series reflects the growth in recognition of the importance of the application of human factors in the railway context. Through the efforts of the conference committees over the years, the conference has maintained a clear focus on human factors and ergonomics, as understood and defined by bodies such as the International Ergonomics Association, and its application to mainline, metro and light rail systems. As railways and human factors develop and evolve the focus of the conference has varied, with examples of conference headlines including "Supporting the integrated railway", "Supporting reliability, safety and cost reduction" and "Human Factors at the Heart of the Railway". The conference also reflects the truly global nature of rail human factors with contributions from Great Britain and across Europe, North America, Australia, South Africa, Japan, China and Korea.

It would be difficult to provide a comprehensive list of the key individuals who have contributed to shaping and organising each of these conferences. However, it is possible to identify some of the key companies and institutions who have provide leadership for this conference: Network Rail, Rail Safety and Standards Board (RSSB), University of Nottingham, Japan Railway East, International Union of Railways (UIC), the European Rail Agency, Rail Accident Investigation Branch, Chartered Institute of Ergonomics and Human Factors, the UK Rail Research and Innovation Network and the University of Newcastle.

Nevertheless, it is important to remember that conferences themselves are socio-technical systems (perhaps on a small scale) and that it is the organisations, organisers, attendees and paper authors who have created a corpus of human factors railway knowledge and understanding through these conferences. Prior to this sequence of conferences, railway human factors research was distributed across many conferences which even in the digital age can become lost. The rail human factors conferences provide a set of railway human factors knowledge which can be learnt from, re-applied and developed over time. It is also a very positive sign that the seventh conference has led to the publication of this journal special issue, indicating the quality of work presented at the conference.

Emerging trends in rail human factors

As this special issue relates to the seventh and most recent meeting of the conference, it is interesting to compare the focus of the 76 papers at this conference with the 49 papers at the first conference in York, UK, in 2003, published in an edited book (Wilson et al, 2005).

In 2003, this initial conference included three publications providing perspectives on the past, present and future of rail human factors, and two reflections on human factors from within two

dominant rail organisations in Great Britain (RSSB and Network Rail). Approximately one-third of the contributions related to driving (17), with a focus on train driver behaviour, vision and visual strategies, devices in the cab, signs / signals and SPADs (signals passed at danger) and driver fatigue. Eleven papers focused on signalling and control; more specifically, control centre design and displays (five), planning and re-planning in rail control (two) and workload in signalling (four). Issues for passengers were covered in three publications (passenger perception of risk, passenger safety signs and evacuation) and staff in two (managing violence, stress management). Five publications were on topics related to human reliability and safety culture (human error risk management, competence management systems, communications errors, safety culture in maintenance, safety at cultural influences). Finally, human factors integration in rail was considered in five publications, including two case studies and papers on ergonomics standards in rail, task specification in designing for railway operations and systems engineering tools for task modelling.

Moving forwards to 2021 and the seventh international conference we see a greater focus on thematic areas, rather than the more overt focus on functions of the railway (such as driving or signalling). Safety and performance are prominent. Seventeen papers relate to safety management, safety culture or accident prevention, including risk models, educational tools, requirements for safety culture, accident causes, SPADs and accident prevention in degraded working. Human or organisational performance was the focus in 16 papers, with examples such as local knowledge in signallers, protection for track workers, teamwork in drivers and network control, along with performance impacts of signaller and controller workload (four papers), and effects of fatigue and underload (three). Seven papers were related to competence, largely non-technical skills (five) or on route knowledge or the review of psychometric assessments. Issues for passengers and members of the public were explored in seven papers, with three on experiences or needs of people with autism or other needs, suicide and trespass (three) and decision-making and behaviour at level crossings. A good number of papers focused on human factors methods (14), six in particular on accident investigation and others on mathematical modelling, human error analysis, simulation, visual stories and reflections on the maturity and future of rail human factors (two). Finally, 15 publications related to virtual / augmented reality (five) (a general overview, VR / AR in training, naturalistic trials, haptic signals), and the design and implementation of new technology (10), such as automation, traffic management systems, driver advisory systems, challenges of the digital railway, new interface design, designing for security and design of seating.

Papers in this special issue

Reflecting the ongoing trends, the papers in this special issue cover the gamut of rail human factors: from physical, through cognitive, to organisational factors; from 'sharp end' railway workers to deeper systemic issues of safety management; and from drivers and signallers through to regulators, accident investigators and the wider public. As may be expected in the discipline of human factors, though, there is much crossover from micro to macro issues within each of these papers. Nevertheless, we have attempted to group them accordingly.

The first group of papers focuses on drivers and signallers on the front line of railway operations. We start with physical ergonomics, with a paper from **Naweed et al.** exploring work-related musculoskeletal disorders and injuries in tram drivers. The authors took a systemic perspective on the problem, identifying issues associated with organisational culture as well as design.

We move from there to a series of cognitive studies, mostly examining various aspects of train driving. **Verstappen et al.** address workload and attention in their experiment on Driver Advisory Systems - additional interfaces in the driving cab providing extra information on aspects of the route,

timekeeping and energy efficiency. The concern, which has not been adequately addressed in previous research, is whether such devices cause excessive workload or distraction. We will share no spoilers here but, as a teaser, there are also interesting implications for mental underload.

The next paper, from **van der Weide et al.**, also looks at a new technology in the driving cab, in the form of the European Rail Traffic Management System. The authors concern themselves with the training implications of transitioning to this new way of driving, drawing on big data analysis to make recommendations for minimum levels of training. Staying in the driving cab, **Harrison et al.** add to the literature base on human reliability with operational data from two key driving tasks: stopping at red signals and approaching buffer stops. Big data again plays a part as the authors explain a new tool developed in the GB rail industry to estimate the number of times a signal is approached at red, thereby enabling the assessment of human reliability by providing the denominator in the analysis of signals passed at danger. These authors offer useful insights on system error management and the limits of human reliability.

Another key determinant of human reliability on the 24/7 railway is fatigue. **Basacik and Tailor** explain the significant contribution of fatigue to rail incidents, putting sleep under the microscope through a wide-scale survey of railway staff. As the authors describe it, a 'feast-and-famine' pattern emerges in which workers run low on sleep when working, especially when working nights, and then catch up on their rest days.

As **Naweed and Murphy** point out in their opening, it is not just drivers who drive trains, but the whole system. Their paper looks at the non-technical skills of network controllers, particularly in relation to teamworking where members of the team may be distributed. In a similar context, **Golightly and Young** consider the key role that local knowledge plays in railway signalling - an increasingly important concern as signalling moves towards more centralised control. Signallers have to balance performance against safety on a daily basis and, as this paper explains, much of that is down to their own experience and decision-making.

Concerns for railway safety and security can come from far and wide, as highlighted by the next two papers. **Silla** examines how to prevent the widespread and tragic incidence of people ending their own lives on the railway, highlighting the impact these events can have not just on those directly involved, but also on the railway staff, emergency services and eyewitnesses. Their paper discusses training for railway staff as well as technological means for recognising the signs of potential suicide. Meanwhile, a significant security threat is described by **Havârneanu et al**. in the form of chemical, biological, radiological, nuclear and explosive attacks. The authors set out the organisational challenges for the railway to work with security authorities and emergency services in preparing for such major incidents.

This organisational-level approach brings us to our last two papers in this special issue. **Waterson et al.** present an innovative application of Bayesian Belief Networks in understanding railway safety management systems, comparing practices from Great Britain and Italy. Their findings highlight some of the pinch points in safety management across organisations. Finally, **Accou and Carpinelli** also address safety management via their Safety Fractal Analysis method for investigating human and organisational factors in incidents. This method takes a logical and consistent approach to probing all the levels of a socio-technical system and leans on ideals of 'work-as-imagined' versus 'work-as-done' in highlighting how and why things went wrong from a human - and organisational - factors perspective.

Concluding comments

As well as being a valuable resource for the rail human factors community, we hope this special issue has wider relevance to the discipline of human factors and ergonomics. The papers reflect many traditional themes (such as musculoskeletal concerns) through to emerging societal challenges (human factors for security and terrorist threat) that are of relevance and interest to many sectors. The papers also represent a wealth of application of methods including qualitative, observational, big data-derived, and with novel analytical forms. Finally, we note the number of papers that come from practice, or from industry-academia collaborations. As such, these papers represent the ways in which different stakeholders can work together to share and develop knowledge and impact within our discipline.

The guest editors are indebted to the authors of the expanded versions of the conference paper. We are also grateful to the time, and thoughtful comments, of the reviewers of papers of this special issue.

Reference

Wilson, J., Norris, B., Clarke, T., & Mills, A. (2017). *Rail human factors: supporting the integrated railway*." Routledge.