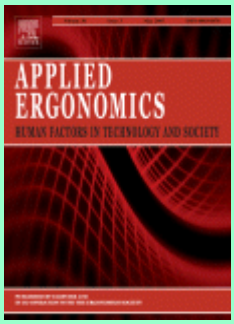
# Applied Ergonomics - rok 2016, Volume 53

# March 2016 – Part B




**Guy Walker, Ailsa Strathie. *Big data and ergonomics methods: A new paradigm for tackling strategic transport safety risks*. Pages 298-311.**

Big data collected from On-Train Data Recorders (OTDR) has the potential to address the most important strategic risks currently faced by rail operators and authorities worldwide. These risk issues are increasingly orientated around human performance and have proven resistant to existing approaches. This paper presents a number of proof of concept demonstrations to show that long standing ergonomics methods can be driven from big data, and succeed in providing insight into human performance in a novel way. Over 300 ergonomics methods were reviewed and a smaller sub-set selected for proof-of-concept development using real on-train recorder data. From this are derived nine candidate Human Factors Leading Indicators which map on to all of the psychological precursors of the identified risks. This approach has the potential to make use of a significantly underused source of data, and enable rail industry stakeholders to intervene sooner to address human performance issues that, via the methods presented in this paper, are clearly manifest in on-train data recordings. The intersection of psychological knowledge, ergonomics methods and big data creates an important new framework for driving new insights.

- **Keywords:** Big data; Leading indicators; Human performance; Methods

**Paul M. Salmon, Michael G. Lenné, Gemma J.M. Read, Christine M. Mulvihill, Miranda Cornelissen, Guy H. Walker, Kristie L. Young, Nicholas Stevens, Neville A. Stanton. *More than meets the eye: Using cognitive work analysis to identify design requirements for future rail level crossing systems*. Pages 312-322.**

An increasing intensity of operations means that the longstanding safety issue of rail level crossings is likely to become worse in the transport systems of the future. It has been suggested that the failure to prevent collisions may be, in part, due to a lack of systems thinking during design, crash analysis, and countermeasure development. This paper presents a systems analysis of current active rail level crossing systems in Victoria, Australia that was undertaken to identify design requirements to improve safety in future rail level crossing environments. Cognitive work analysis was used to analyse rail level crossing systems using data derived from a range of activities. Overall the analysis identified a range of instances where modification or redesign in line with systems thinking could potentially improve behaviour and safety. A notable finding is that there are opportunities for redesign outside of the physical rail level crossing infrastructure,

including improved data systems, in-vehicle warnings and modifications to design processes, standards and guidelines. The implications for future rail level crossing systems are discussed.

- **Keywords:** Rail level crossings; Cognitive work analysis; Systems analysis; Road safety; Rail safety

### Glyn Lawson, Davide Salanitri, Brian Waterfield. *Future directions for the development of virtual reality within an automotive manufacturer*. Pages 323-330.

Virtual Reality (VR) can reduce time and costs, and lead to increases in quality, in the development of a product. Given the pressure on car companies to reduce time-to-market and to continually improve quality, the automotive industry has championed the use of VR across a number of applications, including design, manufacturing, and training. This paper describes interviews with 11 engineers and employees of allied disciplines from an automotive manufacturer about their current physical and virtual properties and processes. The results guided a review of research findings and scientific advances from the academic literature, which formed the basis of recommendations for future developments of VR technologies and applications. These include: develop a greater range of virtual contexts; use multi-sensory simulation; address perceived differences between virtual and real cars; improve motion capture capabilities; implement networked 3D technology; and use VR for market research.

- **Keywords:** Automotive; Human factors; Virtual reality

### Neville A. Stanton, Don Harris, Alison Starr. *The future flight deck: Modelling dual, single and distributed crewing options*. Pages 331-342.

It is argued that the barrier to single pilot operation is not the technology, but the failure to consider the whole socio-technical system. To better understand the socio-technical system we model alternative single pilot operations using Cognitive Work Analysis (CWA) and analyse those models using Social Network Analysis (SNA). Four potential models of single pilot operations were compared to existing two pilot operations. Using SOCA-CAT from CWA, we were able to identify the potential functional loading and interactions between networks of agents. The interactions formed the basis on the SNA. These analyses potentially form the basis for distributed system architecture for the operation of a future aircraft. The findings from the models suggest that distributed crewing option could be at least as resilient, in network architecture terms, as the current dual crewing operations.

- **Keywords:** Flight deck; Crewing; Modelling; Cognitive work analysis; Social network analysis

### M. Bedinger, G.H. Walker, M. Piecyk, P. Greening. *21st century trucking: A trajectory for ergonomics and road freight*. Pages 343-356.

Over the past decade there has been significant pressure to minimise emissions and safety risks related to commercial driving. This pressure to meet the triple bottom line of cost, environment, and society has often resulted in the rapid application of vehicle technologies designed to mitigate undesired effects. Often the cognitive and behavioural effects of technologies on the commercial driver have not received in-depth analysis to determine comprehensive viability. As such, this paper aims to identify a timescale for implementation for future technologies for UK road freight, and likely associated human factors issues, improving upon the currently employed 'trial-and-error' approach to implementation which may carry high economic, environmental, safety-related risk. Thought experiments are carried out to broadly explore these future systems.

Furthermore, this work aims to examine whether technology alone will be enough to meet future CO2 reduction targets, and assess the role of behavioural and systems interventions for future research.

- **Keywords:** Heavy goods vehicles; Commercial vehicle drivers (CVD); Roadmapping

### S.J. Legg, A. Gilbey, S. Hill, A. Raman, A. Dubray, G. Iremonger, T. Mündel. *Effects of mild hypoxia in aviation on mood and complex cognition*. Pages 357-363.

Thirty six volunteer air force personnel were sequentially exposed in a randomized balanced order in a hypobaric chamber to 30 min of baseline (sea level) and mild hypoxia induced by a specified altitude (sea level, 8000 ft and 12,000 ft), followed immediately by breathing 100% oxygen from an oro-nasal mask. Mood and complex cognition were assessed. Analysis of variance indicated that mood (fatigue and vigour) remained the same at 8000 ft but fatigue was increased ($p = 0.001$) and vigour reduced ($p = 0.035$) at 12,000 ft and was restored by supplementary oxygen. Complex cognition was not significantly altered by the test conditions. The results of this study do not support prior evidence that mild hypoxia equivalent to either 8000 or 12,000 ft, impairs complex cognition, but suggests that some aspects of mood may be affected at 12,000 ft and can be restored by breathing 100% oxygen.

- **Keywords:** Aviation; Altitude; Psychology; Performance; Stressors

### Neville A. Stanton, Katherine L. Plant, Aaron P. Roberts, Catherine Harvey, T.Glyn Thomas. *Extending helicopter operations to meet future integrated transportation needs*. Pages 364-373:

Helicopters have the potential to be an integral part of the future transport system. They offer a means of rapid transit in an overly populated transport environment. However, one of the biggest limitations on rotary wing flight is their inability to fly in degraded visual conditions in the critical phases of approach and landing. This paper presents a study that developed and evaluated a Head up Display (HUD) to assist rotary wing pilots by extending landing to degraded visual conditions. The HUD was developed with the assistance of the Cognitive Work Analysis method as an approach for analysing the cognitive work of landing the helicopter. The HUD was tested in a fixed based flight simulator with qualified helicopter pilots. A qualitative analysis to assess situation awareness and workload found that the HUD enabled safe landing in degraded conditions whilst simultaneously enhancing situation awareness and reducing workload. Continued development in this area has the potential to extend the operational capability of helicopters in the future.

- **Keywords:** Helicopters; Head up display; Cognitive work analysis

### Cyriel Diels, Jelte E. Bos. *Self-driving carsickness*. Pages 374-382.

This paper discusses the predicted increase in the occurrence and severity of motion sickness in self-driving cars. Self-driving cars have the potential to lead to significant benefits. From the driver's perspective, the direct benefits of this technology are considered increased comfort and productivity. However, we here show that the envisaged scenarios all lead to an increased risk of motion sickness. As such, the benefits this technology is assumed to bring may not be capitalised on, in particular by those already susceptible to motion sickness. This can negatively affect user acceptance and uptake and, in turn, limit the potential socioeconomic benefits that this emerging technology may provide. Following a discussion on the causes of motion sickness in the context of self-driving cars, we present guidelines to steer the design and development of

automated vehicle technologies. The aim is to limit or avoid the impact of motion sickness and ultimately promote the uptake of self-driving cars. Attention is also given to less well known consequences of motion sickness, in particular negative aftereffects such as postural instability, and detrimental effects on task performance and how this may impact the use and design of self-driving cars. We conclude that basic perceptual mechanisms need to be considered in the design process whereby self-driving cars cannot simply be thought of as living rooms, offices, or entertainment venues on wheels.

- **Keywords:** Vehicle automation; Design; Displays; Motion sickness; Carsickness; Sensory conflict; Anticipation

### Dale Richards, Alex Stedmon. *To delegate or not to delegate: A review of control frameworks for autonomous cars*. Pages 383-388.

There have been significant advances in technology and automated systems that will eventually see the use of autonomous cars as commonplace on our roads. Various systems are already available that provide the driver with different levels of decision support. This paper highlights the key human factors issues associated with the interaction between the user and an autonomous system, including assistive decision support and the delegation of authority to the automobile. The level of support offered to the driver can range from traditional automated assistance, to system generated guidance that offers advice for the driver to act upon, and even more direct action that is initiated by the system itself without driver intervention. In many of these instances the role of the driver is slowly moving towards a supervisory role within a complex system rather than one of direct control of the vehicle. Different paradigms of interaction are considered and focus is placed on the partnership that takes place between the driver and the vehicle. Drawing on the wealth of knowledge that exists within the aviation domain and research literature that examines technology partnerships within the cockpit, this paper considers important factors that will assist the automotive community to understand the underlying issues of the human and their interaction within complex systems.

- **Keywords:** Autonomy; Automation; Control; Human factors

### Victoria A. Banks, Neville A. Stanton. *Keep the driver in control: Automating automobiles of the future*. Pages 389-395.

Automated automobiles will be on our roads within the next decade but the role of the driver has not yet been formerly recognised or designed. Rather, the driver is often left in a passive monitoring role until they are required to reclaim control from the vehicle. This research aimed to test the idea of driver-initiated automation, in which the automation offers decision support that can be either accepted or ignored. The test case examined a combination of lateral and longitudinal control in addition to an auto-overtake system. Despite putting the driver in control of the automated systems by enabling them to accept or ignore behavioural suggestions (e.g. overtake), there were still issues associated with increased workload and decreased trust. These issues are likely to have arisen due to the way in which the automated system has been designed. Recommendations for improvements in systems design have been made which are likely to improve trust and make the role of the driver more transparent concerning their authority over the automated system.

- **Keywords:** Automation; Driver trust; Driver workload; Thematic analysis