

THE HUMAN FACTORS OF SIMULATION AND ASSESSMENT SERIES

# Simulators for Transportation Human Factors

Research and Practice



Edited by Mark S. Young and Michael G. Lenné



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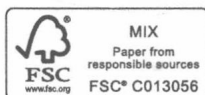
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# THE HUMAN FACTORS OF SIMULATION AND ASSESSMENT

Series Editors

**Michael G. Lenné**

*Monash University Accident Research Centre, Australia*

**Mark S. Young**

*Loughborough Design School, Loughborough University, UK*

Ongoing advances in lower-cost technologies are supporting a substantive growth worldwide in the use of simulation and naturalistic performance assessment methods for research, training and operational purposes in domains such as road, rail, aviation, mining and healthcare. However, this has not been accompanied by a similar growth in the expertise required to develop and use such systems for evaluating human performance and state. Whether for research or practitioner purposes, many of the challenges in assessing operator performance and state, both using simulation and in natural environments, are common. What performance measures should be used, what technology can support the collection of these measures across the different designs, how can other methods and performance measures be integrated to complement objective data and how should behaviours be coded and the performance standards measured and defined? How can these approaches be used to support product development and training, and how can performance within these complex systems be validated? This series addresses a shortfall in knowledge and expertise by providing a unique and dedicated forum for researchers and experienced users of simulation and field-based assessment methods to share practical experiences and knowledge in sufficient depth to facilitate delivery of practical guidance.

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# Simulators for Transportation Human Factors

Research and Practice



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## *Preface*

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Simulation continues to be a growth area in transportation human factors. From the long pedigree in aviation for pilot training, the use of simulators has since widened to cars, lorries, motorcycles, trains and ships, with applications ranging from empirical studies in the laboratory to the latest training techniques in the field.

Much of this growth seems to have occurred over the last 20 years. Two decades ago, the use of simulators in automotive human factors research was just gaining traction, with several laboratories having driving simulators of varying levels of fidelity. The first editor recalls his early experiences in this field using half a car connected to a computer running bespoke driving simulator software. (It was the front half of the car, fortunately.) Meanwhile, the rail and maritime transport modes had yet to really take advantage of simulators for research or training.

That situation was changing by 2004, when the UK Ergonomics Society (now the Chartered Institute of Ergonomics and Human Factors) convened a one-day conference that emphasised the diverse nature of simulators across the transport modes and demonstrated the popularity of this method for both researchers and practitioners. Today, simulators are being increasingly used within transport organisations to support operator training and performance assessment (particularly in rail and maritime), whilst growth in research is reflected by a noticeably increasing publication count where simulation is the primary research methodology (especially in automotive human factors).

Such progress has, of course, run in parallel with developments in both software and hardware technology. The availability of lower-cost personal computer (PC)-based technology has made (and continues to make) simulation a more widely accessible and affordable tool for both training and research worldwide. Whilst some laboratories showcase the higher-end motion-based simulators, there are many more research programmes using commercial and off-the-shelf (often PC-based) simulator systems.

Whilst the use of simulators in transportation human factors continues to grow, we feel that it is not accompanied by a similar expansion in the knowledge and expertise required to develop and use such systems. This book aims to fill that gap by drawing together current trends in simulator use for both research and training in the road, rail, air and maritime sectors.

The book is designed to appeal to a broad audience of transport researchers and practitioners across academia and industry who focus on human factors and performance assessment. The chapters, from a selection of international experts in their field, discuss traditional uses of simulators in transport (such as pilot training and automotive research) as well as less common

applications (including driver training and rail research). The material focuses on simulator use rather than simulator development, but there is information in here that can help those looking to develop a functional requirements specification for a simulator. It is not intended as a handbook, but as a source of literature and case studies as well as a means for sharing experiences and lessons across the transport domains. By bridging research and practice in all of the transport modes, readers will have an accessible overview of the latest simulator techniques and studies across the gamut of transportation human factors.



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## *Acknowledgements*

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## *Editors*

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**Mark S. Young** is a visiting professor at Loughborough Design School, Loughborough University, UK. He has a BSc degree in psychology and a PhD degree in cognitive ergonomics, and is a chartered ergonomist and human factors specialist with the Chartered Institute of Ergonomics and Human Factors (CIEHF). Mark has previously held visiting fellow positions in the Department of Aviation, University of New South Wales, and at Curtin University in Perth, Australia. He also served as an editor of the journal *Ergonomics* from 2010 to 2015. His interests focus on the human factors of transport systems, and much of his work has been based in simulators, investigating issues such as driver workload, distraction, and the effects of automation and novel technologies.

**Michael G. Lenné** is an adjunct professor (research) at the Monash University Accident Research Centre (MUARC), Clayton, Australia. He earned a PhD in experimental psychology from Monash University in 1998 and has spent the last 18 years working on the roles of human factors in both government and university settings. Until late 2014, Dr Lenné was a professor at MUARC, where he led the human factors research team for nearly eight years. His research used driving simulators and instrumented vehicles to study the impacts of in-vehicle technologies on driver behaviour and to measure driver responses to distraction, drowsiness and other forms of impairment. He is currently the chief scientific officer of Human Factors at Seeing Machines, where his research is centred on characterising and validating metrics for driver-state assessments in automotive, heavy vehicle and aviation sectors.

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## **Section I**

# **Introduction**





# 1

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## Prologue

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### 1.1 Advance of Transport Simulators

Simulators are vital tools in transportation human factors. From empirical studies in the laboratory to the latest training techniques in the field, simulators have been offering benefits to researchers and practitioners across the transport modes for many years.

The story of simulators in transport begins in aviation, where they originally evolved as training tools that allowed aircrew to experience aspects of flight operations and systems without actually flying real aircraft (Stedmon et al. 2012). The earliest flight simulators were developed in the interwar years as a cost-effective means of training military personnel when real aircraft were not available or were in short supply. This approach then migrated to civil aviation for commercial pilot training with the development of multimillion-pound simulators that we are perhaps more familiar with and that are now used regularly for routine and refresher training.

Nowadays, simulators are common across many transportation modes. Along with technological developments and the rise of powerful computer processing capabilities, there have been significant investment and expansion of simulators specifically for automotive, rail and maritime applications. Nevertheless, the evolution of these simulators has progressed along largely independent paths that have led to many different