

**Unsettled Impacts of  
Integrating Automated  
Electric Vehicles  
into a Mobility-as-a-  
Service Ecosystem and  
Effects on Traditional  
Transportation and  
Ownership**

**Dr. Joachim Taiber  
Dr. Raivo Sell**

# Unsettled Impacts of Integrating Automated Electric Vehicles into a Mobility-as-a-Service Ecosystem and Effects on Traditional Transportation and Ownership

**Dr. Joachim Taiber**

*International Transportation Innovation Center (ITIC), USA*

**Dr. Raivo Sell**

*Tallinn University of Technology, Estonia*

---

**EDGE DEVELOPMENT TEAM**

---

Dr. Robert Shorten, *Imperial College London*

Alexander Kraus, *TÜV SÜD*

Dan Baxter, *Stantec*

Ronald Grosse, *Bertrandt*

Dr. Reinhard Pfliegl, *A3PS*

Dr. Jim Martin, *Clemson University*

Mathew Yager, *IOTA Foundation*

Sean Kelley, *Mannik & Smith Group*

Hendrik Kramer,  
*Technical University of Munich*

Dr. Flavio Bonomi, *Nebbiolo Technologies and  
Lynx Software Technologies*





## About the Publisher

SAE International® is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive, and commercial-vehicle industries. Our core competencies are lifelong learning and voluntary consensus standards development. Visit [sae.org](http://sae.org)

## SAE EDGE™ Research Report Disclaimer

SAE EDGE™ Research Reports focus on topics that are dynamic, in which knowledge is incomplete, and which have yet to be standardized. They represent the collective wisdom of a group of experts and serve as a practical guide to the reader in understanding unsettled subject matter. They are not meant to provide a recommended practice or protocol. The experts engaged have contributed their own thoughts and points of view and these are not the positions of the institutions or businesses with which they are affiliated. A professional writer has collectivized their input; there is no one contributor's perspective being advanced, but rather that of a community of practitioners. SAE EDGE™ Research Reports are the property of SAE International and SAE alone is responsible for their content.

## About This Publication

SAE EDGE™ Research Reports provide state-of-the-art and state-of-the-industry examinations of the most significant topics in mobility engineering. SAE EDGE™ contributors are experts from research, academia, and industry who have come together to explore and define the most critical advancements, challenges, and future direction in areas such as vehicle automation, unmanned aircraft, Internet of Things and connectivity, cybersecurity, advanced propulsion, and advanced manufacturing.

## Related Resources

**SAE MOBILUS® Automated & Connected Knowledge Hub**  
<http://sae.org/Mobilus/Automated>

## SAE Team

Frank Menchaca, Chief Product Officer  
Michael Thompson, Director, Standards, Information and Research Publications  
Monica Nogueira, Acquisitions Director  
Jill Leonard, Product Manager  
William Kucinski, Managing Technical Editor

---

Copyright © 2020 SAE International. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, distributed, or transmitted, in any form or by any means without the prior written permission of SAE International. For permission and licensing requests, contact SAE Permissions, 400 Commonwealth Drive, Warrendale, PA 15096-0001 USA; e-mail: [copyright@sae.org](mailto:copyright@sae.org); phone: 724-772-4028; fax: 724-772-9765.

Printed in USA

Information contained in this work has been obtained by SAE International from sources believed to be reliable. However, neither SAE International nor its authors guarantee the accuracy or completeness of any information published herein and neither SAE International nor its authors shall be responsible for any errors, omissions, or damages arising out of use of this information. This work is published with the understanding that SAE International and its authors are supplying information, but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

ISSN 2640-3536

e-ISSN 2640-3544

ISBN 978-1-4686-0110-7

To purchase bulk quantities, please contact: SAE Customer Service

E-mail: [CustomerService@sae.org](mailto:CustomerService@sae.org)

Phone: 877-606-7323 (inside USA and Canada)  
724-776-4970 (outside USA)

Fax: 724-776-0790

Visit the SAE International Bookstore at [books.sae.org](http://books.sae.org)

## About the Editors



Born and raised in Germany, **Dr. Taiber** enjoyed his academic training at the Swiss Federal Institute of Technology in Zurich (ETHZ), Switzerland, where he first graduated with a master's degree in Mechanical Engineering in 1991 and then completed his PhD in Technical Sciences in 1996.

After his studies, Dr. Taiber started his professional career at a Swiss software start-up company in Zurich. He joined Bayerische Motoren Werke AG (BMW) Group in Munich in 1997 as in-house consultant in the vehicle development division where he worked on different aspects of functional integration and validation of vehicle systems, vehicle electronics platforms, and vehicle program management. He assisted the CEO as technology advisor and supported the CIO in a major reorganization of the Information Technology (IT) division which resulted in holding different leadership positions in the areas of IT strategy, program management, innovation management, and benchmarking.

In 2003, Dr. Taiber was engaged in the initial planning of an automotive research campus in Greenville, South Carolina, closely located to the BMW US manufacturing site that served as a public-private partnership model and helped shape strategic collaboration between BMW and Clemson University. The first facility created on the Clemson University International Center for Automotive Research (CU-ICAR) campus in 2005 was the BMW Information Technology Research Center (ITRC) - a dedicated building designed to collaborate with BMW IT partners on open innovation and

strategic advanced technology projects including the aspects of the “networked vehicle” and the “next generation data center.” Dr. Taiber led innovation activities at ITRC as director of the Information Technology Research Office for multiple years and worked closely with the BMW Tech Office in Silicon Valley, large technology companies, start-ups, and universities.

In 2010, Dr. Taiber joined Clemson University as research professor and member of the Automotive Engineering, Electrical and Computer Engineering, and Computer Science faculty. In 2012, he created the Advanced Vehicle-Infrastructure Technology Institute under the College of Engineering and Science, which he directed until the end of 2015. During his academic engagement, Dr. Taiber worked intensively on the development of vehicle electrification and charging infrastructure, connected vehicle systems, and intelligent transportation infrastructure.

In January 2016, Dr. Taiber was appointed Chief Technology Officer of the International Transportation Innovation Center, a nonprofit organization headquartered in Greenville, focused on developing and applying innovative methods of system validation for connected, automated, shared, and sustainable forms of mobility with industrial and academic partners. He also initiated a global consortium effort for the design and operation of smart mobility testbeds led by the Society of Automotive Engineers (SAE International) - the International Alliance for Mobility Testing and Standardization (IAMTS).

Through his private consulting practice, Dr. Taiber is involved in the development, implementation, and operation of open and closed mobility testbeds both at a national and international scale. Additionally, through a private venture practice, he engages in the development of new mobility-related businesses.

He continues to serve Clemson University as adjunct professor at CU-ICAR. Dr. Taiber still acts as a smart mobility advisor of the IOTA Foundation (blockchain and distributed ledger technologies) and is active in transportation-related standards development efforts both at SAE and IEEE. He is also member of the advisory board of the Peace Innovation Foundation which works closely with the United Nations.



**Raivo Sell** received his PhD in Product Development from Tallinn University of Technology in 2007. His research interests cover early design issues on mobile robotics and self-driving vehicles. He currently runs the Autonomous Vehicles Laboratory-Competence Center at TalTech as a research group leader.

Raivo Sell has been a visiting researcher in ETH Zürich, Aalto University, and, most recently, at Florida Polytechnic University in the USA and recognized as a Chartered Engineer and International Engineering Educator: ING-PAED IGIP. He is an author of several books on the Internet of Things and practical robotics, and has been an educator of robotics teachers in vocational and higher education.

# contents

**About the Editors**

**Unsettled Impacts of Integrating Automated Electric Vehicles into a Mobility-as-a-Service Ecosystem and Effects on Traditional Transportation and Ownership. . . . . 3**

    Introduction . . . . . **4**  
    *State of the Industry* . . . . . **4**

**Unsettled Issues Concerning Integrating Automated Electric Vehicles into a MaaS Ecosystem and Effects on Traditional Transportation and Ownership . . . . . 7**

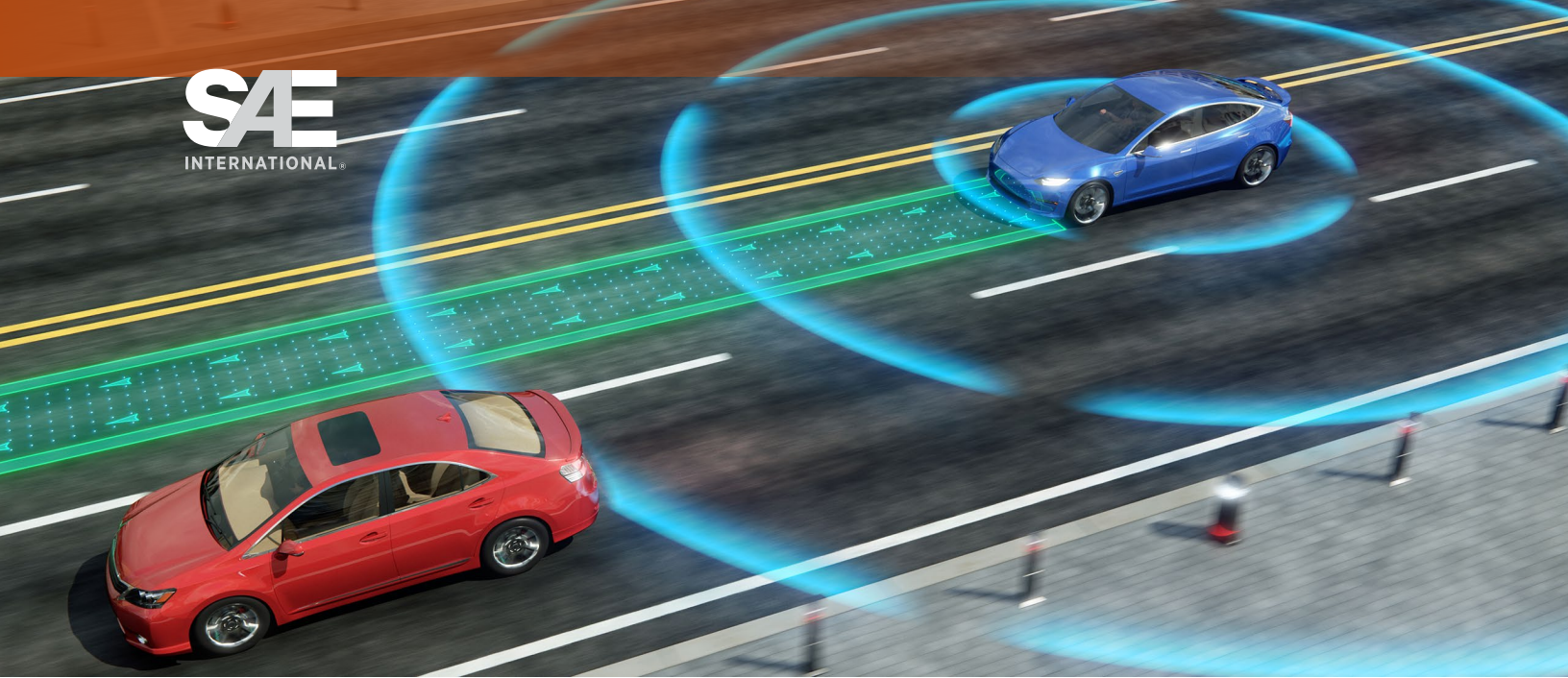
**True Cost of Automated Driving and Speed of Adoption . . . . . 7**  
    *Recommendations* . . . . . **10**

**Lagging AI and Regulations. . . . . 10**  
    *Recommendations* . . . . . **12**

**Electric Vehicle Mass Adoption Has a Significant Impact on the MaaS Ecosystem. . . . 12**  
    *Recommendations* . . . . . **13**

**Competitive and Collaborative Forces for Automotive OEMs Regarding Self-driving Technology . . . . . 13**  
    *Recommendations* . . . . . **14**

**Summary/Conclusions . . . . . 14**  
    *SAE EDGE™ Research Reports* . . . . . **14**  
    *Next Steps for Integrating Automated Electric Vehicles into a MaaS Ecosystem* . . . . . **15**  
    *Recommendations* . . . . . **15**  
    *Abbreviations/Definitions* . . . . . **15**  
    *Acknowledgments* . . . . . **16**  
    *Works Cited* . . . . . **17**  
    *Contact Information* . . . . . **18**



# Unsettled Impacts of Integrating Automated Electric Vehicles into a Mobility-as-a-Service Ecosystem and Effects on Traditional Transportation and Ownership

## Abstract

The current business model of the automotive industry is based on individual car ownership, yet new ridesharing companies such as Uber and Lyft are well capitalized to invest in large, commercially operated, on-demand mobility service vehicle fleets. Car manufacturers like Tesla want to incorporate personal car owners into part-time fleet operation by utilizing the company's fleet service. These robotaxi fleets can be operated profitably when the technology works in a reliable manner and regulators allow driverless operation.

Although Mobility-as-a-Service (MaaS) models of private and commercial vehicle fleets can complement public transportation models, they may contribute to lower public transportation ridership and thus higher subsidies per ride. This can lead to inefficiencies in the utilization of existing public transportation infrastructure. MaaS platforms can also cause a reduced reliance on parking infrastructure (e.g., street parking lanes and parking garages) which can contribute to an improvement in overall traffic flow, and a reduction in capital investment for commercial and residential real-estate development. Urban planning can be better centered around the true mobility needs of the citizens without sacrificing valuable space for vehicles that are inactive most of the time. A key challenge is the transition phase where traditional forms of car ownership and transportation coexist with new forms of mobility services (before true MaaS platforms are fully optimized). Another fundamental issue is determining the true cost of car ownership and establishing ideal cost structures for on-demand mobility services in order to replace the need of owning a car. This needs to occur without compromising subsidized public transportation which provides affordable transportation for low-income groups.

NOTE: SAE EDGE™ Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE™ Research Reports is to stimulate discussion and work in the hope of promoting and speeding resolution of identified issues. SAE EDGE™ Research Reports are not intended to resolve the issues they identify or close any topic to further scrutiny.

## DR. JOACHIM TAIBER

*International Transportation  
Innovation Center (ITIC), USA*

## DR. RAIVO SELL

*Tallinn University of Technology,  
Estonia*

## Edge Development Team

Dr. Robert Shorten,  
*Imperial College London*  
Alexander Kraus, *TÜV SÜD*  
Dan Baxter, *Stantec*  
Ronald Grosse, *Bertrandt*  
Dr. Reinhard Pfliegl, *A3PS*  
Dr. Jim Martin, *Clemson University*  
Mathew Yager, *IOTA Foundation*  
Sean Kelley, *Mannik & Smith Group*  
Hendrik Kramer,  
*Technical University of Munich*  
Dr. Flavio Bonomi, *Nebbiolo Technologies*

ISSN 2640-3536