INVENTING MOBILITY FOR ALL

Mastering Mobility-as-a-Service with Self-Driving Vehicles

ANDREAS HERRMANN
JOHANN JUNGWIRTH

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BY

ANDREAS HERRMANN
University of St. Gallen, Switzerland

AND

JOHANN JUNGWIRTH
Mobileye, Israel

United Kingdom – North America – Japan – India
Malaysia – China

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INVESTOR IN PEOPLE

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FOREWORD

What drove us to write a book about Mobility-as-a-Service? First and foremost, we care about human-centric mobility solutions, which will determine this century. Sure, it's also about technology and more precisely about electric, connected, and above all autonomous vehicles that you can summon with an app. It is about self-driving cars and buses controlled via a mobility platform. But it's also about connecting all those cars, buses, trains, and the various forms of micro-mobility to create seamless transportation. Imagine driving with no steering wheel … how fascinating is that?! Mobility in its new guise can lend a whole new shape to our lives, our daily routines, and of course our transportation choices. We can reinvent the very notion of travel.

Some of the finer points of the Mobility-as-a-Service concept still must be firmed up. Some aspects are still vague. We nevertheless felt it was important to embark on this tour d'horizon as few other accomplishments will likely transform our lives and the way we go places to the same extent as electric, connected, autonomous driving in conjunction with other modes of transportation. So, the time has come to address the concept of 'mobility at the push of a button', to foster public debate on the subject and to play our part in helping it change our lives for the better.

For us as the authors, engaging with this topic has been a moving experience in more ways than one, above all because discussions of vehicles, sensors, algorithms, and mobility platforms only scratch the surface of what this is really about. More fascinating still are the stories behind the new opportunities that Mobility-as-a-Service opens up for people. Especially in the megacities of this world, we can see for ourselves every day that mobility is one of the most important prerequisites for personal freedom and indeed personal development. If, through mobility on demand, we can succeed in transporting people faster, farther, and more easily, these people will

gain access to better jobs and higher pay and have greater control over their lives. And think of people with impairments or disabilities, the elderly and the young who, in many countries and cities, are dependent on outside help to have any chance at all of a social life and participating in society. Consider the rural areas where the younger generation moves away, leaving the elderly behind, stores close, and even such essential services as a local general practitioner are no longer available. Providing inclusive Mobility-as-a-Service with autonomous vehicles for people, goods, and services could form at least part of the solution to these problems.

But there is even more at stake. At the UN Climate Change Conference in Paris in December 2015, 197 countries signed a new, global climate protection agreement that aims to limit global warming to 1.5 degrees Celsius compared to the pre-industrial era. To reach this goal means attaining carbon neutrality worldwide in the second half of this century; that is to say, not generating more emissions than can be sequestered by forests and other carbon reservoirs. It is imperative for the transportation sector to play its part in achieving carbon neutrality.

Just how important this is can be illustrated by any number of memorable and moving stories – experiences, for example, of the people in many Asian and African cities who are at risk of suffocating in the exhaust fumes emitted by the soaring numbers of vehicles on the roads. Then there are the gigantic projects being undertaken in many metropolises to expand the transportation infrastructure in response to the spiralling mobility needs of their inhabitants. And when we factor in the millions of pedestrians, cyclists, drivers, and passengers killed or injured in road traffic accidents, there is no avoiding the truly decisive questions: Don't we finally need to organise our mobility better? Aren't the social costs way too high? Can we still afford this kind of mobility, knowing full well that it could be done better? Therefore let's go. Let's embark on this journey. Let's get on the trail of Mobility-as-a-Service and see what this innovative concept has to offer.

Many faculty members, colleagues, experts, and leading figures from the fields of politics, business, and society have provided us with ideas and inspiration. We would like to thank them all for their readiness to share their knowledge and experience. Our discussions

with Chris Urmson on autonomous and connected driving; with Anat Bonshtien on the new mobility industry in Israel; with Seung Won Kim on Daegu Smart City in South Korea; and with Cem Özdemir on the challenges for government and society were particularly valuable. And a special vote of thanks goes to Niall Kennedy from Emerald Publishing for his support. He's been a keen advocate of this project since the outset.

The outcome, we hope, is a book that sheds light on this subject from a variety of angles and that contributes to an open, honest, multilayered, and nuanced discussion of the opportunities of Mobility-as-a-Service. We, the authors are, we admit, euphoric and optimistic. We want change! We are convinced that electric, connected, and above all autonomous driving will change our lives, our environment, and our society for the better, in a world where mobility is no longer necessarily owned but used as a service. But of course, there are also doubts and concerns, and these too you will find reflected on the following pages.

Andreas Herrmann
Johann Jungwirth (JJ)

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PREFACE I

Mobility is a topic that concerns all of us and is part and parcel of our everyday lives. We travel to work; visit family and friends; go to a doctor's appointment; or take a trip to the local library, museum, or sports facility.

Mobility is a triumph of civilisation and at the very roots of urbanisation. The nature of our urban lives is shaped by the forms of mobility at our disposal. The identity of a city is inseparable from its iconic transportation system: London's black cabs, the Tokyo Metro, the tuk-tuks in Bangkok and the three-wheelers in Mumbai, the freeways of Los Angeles and Dallas. According to Mark Twain, travel broadens the mind. Mobility also enables people to leverage their economic potential and empowers them to dream. But is the price of mobility not too high?

Andreas Herrmann and Johann Jungwirth take us along on a highly topical post-pandemic tour d'horizon through the diverse aspects of mobility – personal, societal, technological, and economic – complete with numerous deep dives into scenarios from across the globe where new mobility concepts are taking shape.

Given the evident growth of our cities and the associated social costs of mobility, such as traffic jams, space used for parking vehicles, air pollution, road accidents, and the like, simply continuing with 'business as usual' is not an option. Systemic change is inevitable. Interweaving autonomous, connected, and electric mobility within a system where vehicles are shared and the different modes of transportation are digitally linked and coordinated promises to deliver the technical basis for the development of a comprehensive solution. But by choosing to call their book 'Inventing Mobility for All', the authors serve notice that they are casting their net even wider.

What are the economic and behavioural forces of inertia that we encounter on the road to this new mobility? The automotive

industry is a significant economic factor and employer. On the one hand, the shift to electric mobility is creating new jobs. On the other hand, it is rendering many jobs obsolete, particularly at small- and medium-sized companies in the supplier sector. And aren't cars also status symbols, sources of pleasure, and safe havens that we have no desire to share? Are people really ready to make the leap from the individualistic 'city of play' to the utilitarian 'city of speed'? The '15-minute city' with its rhythms that coincide with the natural pace of human life provides a vision, but getting there will ask a great deal of each individual. In many places, this will mean scaling back the physical infrastructure and bidding farewell to our everyday routines.

Does Mobility-as-a-Service (MaaS) make economic sense and will it create prosperity? To date, no entirely convincing business model has been identified, and the automotive industry is backtracking. Clearly, MaaS can only succeed where many people embrace it, which is mainly the case among the millennials and digital natives in our megacities, who have grown up with the sharing economy. But what about people who live in rural areas and feel left behind? What does new mobility look like there and how economical can it be? What about those who live in the slums of our major cities, with no local mass transit system available to them and only limited access to jobs and public utilities?

What could a carrot-and-stick system look like that involves and motivates people, while also taking them by the hand and leading them through the systemic shift with appropriate policies and infrastructure changes?

Rich in examples of potential approaches and the innovations that lie ahead, this book adopts a global perspective and targets an international audience. It represents a truly felicitous balance of optimism and reflection.

Christoph Wolff
Executive Committee
World Economic Forum
(Summer 2021)

PREFACE II

Across the globe, people complain about traffic jams and delays. When we look around, it seems as if the mobility we've all come to love has reached its limits in many places. In Africa, as well as in parts of Asia and Latin America, the number of traffic fatalities and injuries continues to rise. And here in Europe as well, too many people still die in road accidents. 'Vision Zero', the goal of eliminating road fatalities entirely, is still a long way off. In addition, exhaust fumes mean that people have to wear smog masks in some parts of the world. At the same time, more and more valuable land is sealed every year to accommodate rising levels of traffic. And as if that wasn't enough, our current mode of mobility is also a major driver of the climate crisis. Around 25% of all carbon dioxide emissions are generated by the transportation sector.

There's no doubt about it: If we intend to overcome the challenges set out above, we're going to have to rethink our approach to mobility. We need a mobility revolution. And our main challenge here will be successfully reconciling two apparently conflicting goals. On the one hand, mobility is doubtless a key requirement for enabling people to find work and earn a living. Without mobility, there is no participating in social life and in the dialog between people, cultures, countries, and continents. So there can be no question of fundamentally restricting mobility or making it more expensive across the board.

On the other hand, if we do not change course, it will be at great cost to humanity, the climate, and the environment. If we are to achieve the goals set out in the Paris Agreement and not to leave a broken planet to our children and grandchildren, we need to take urgent action. We need to stop building our cities around traffic and instead shape traffic to meet people's needs going forward. Consider this: At present around one third of a city's land area is given over to transportation. That's no way to achieve quality of life, liveable urban spaces, economy, and efficiency!

So how can we reconcile these two goals? Along with a strong local public transportation offering, the massive expansion of the rail network and of bike traffic, the keywords here are 'electric', 'connected', 'autonomous', and 'shared'.

When it comes to drivetrain systems, in the passenger car sector the die is already cast: On the road to climate neutrality, virtually all the leading automobile manufacturers have opted for electric mobility. Compared with cars powered by hydrogen fuel cells and internal combustion engines which one day will run on synthetic fuels, the electric car has the advantage of being able to harness green power almost directly. A car running on synthetic fuel requires five to six times as much electricity as a battery-powered model on account of the fuel conversion process. The crucial factor in the electrification of our traffic is that we succeed in generating sufficient electricity from renewables. The mobility revolution is also an energy revolution. And without the energy revolution, it cannot work.

At the same time, we need to rapidly ensure that vehicles are connected with one another and with the infrastructure. Talking traffic lights, for example, can inform approaching vehicles that they are about to change from green to red. The cars will then automatically slow down and reach the lights as they turn green, at which point they accelerate again. This has the potential to save a lot of energy. Autonomous driving would take things a step further. Vehicles would drive along in traffic like pearls on a string. Manoeuvres would be smooth, making jerky stop-and-go traffic a thing of the past – with an enormous impact on energy consumption and emissions.

That's all well and good. But in terms of climate action, autonomous driving will only truly come into its own if we can persuade more and more people to share rides. Think about it: As a standalone module, autonomous driving harbours the often-cited risk that it will actually increase the number of vehicles on the road. For us and our climate, it makes a world of difference whether the autonomous vehicle is a sport utility vehicle (SUV), powering several miles to a downtown parking garage, or a shuttle that bundles multiple personal itineraries in the city centre or provides a link

to the suburbs and outlying areas, where bus and rail connections are few and far between. If we make more efficient use of vehicles through ride-sharing and ride-pooling, we can achieve a marked reduction in the number of trips required and vehicles on the road. Not only would this lead to a drop in energy consumption; we'd also have more space in our towns and cities.

All of this is not going to happen of its own accord. It's going to take the right framework and intelligent catalysts to drive the mobility revolution forward. Before us is the opportunity to create a modern, clean, safe, and affordable version of mobility. Let's make the most of it, in the interests of humanity, the environment, and our climate.

Cem Özdemir
Chairman of the Committee for
Transport and Digital Infrastructure
German Parliament
(Summer 2021)

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PREFACE III

Mobility is a source of fulfilment and a freedom.

I believe that this freedom goes hand in hand with preserving the planet and living better together. Anticipating and building the future of mobility is a real challenge for car manufacturers.

The development of new shared mobility services sits on an industrial continuum. It has always been in automotive original equipment manufacturers' (OEMs) nature to show leadership in understanding consumer trends and usages to offer transport services that best meet needs both now and in the future.

Over the recent years, mobility has become more and more multimodal – thanks to shared mobility, micro mobility – today the diversification of mobility business models accelerates, with a market expected to grow by 60% by 2035. In the new mobility value chain, on-board intelligence systems are the new driving force.

Faced with this technological challenge, collaboration is vital, between large companies and public authorities, but also universities and research centres. In shaping tomorrow's mobility, we need to have an ecosystem approach, with software and algorithms playing a major role.

Therefore, we need to challenge ourselves to limit the impact on the climate and on resources and to make mobility more inclusive and safer for everyone. Bringing inclusion through mobility is a strong commitment over the upcoming years for the industry, as mobility can be a source of inequality and is sometimes a necessary hurdle to overcome in getting, keeping, or training for a job. Indeed, 50% of job seekers say they refuse training or employment because they lack transport.

For a more sustainable future, OEMs will need to shape mobility solutions and services that complement the traditional car-buying scheme, which promotes greater asset utilisation through the

circular and sharing economy keeping in mind the expectations of consumers, businesses, operators, and territories.

Luca De Meo
Chief Executive Officer of Renault S.A.
Chairman of Renault s.a.s.
(Summer 2021)