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Today, a steadily growing store of information is called for in order to understand the increasingly complex technologies used in modern automobiles. Functions, modes of operation, components and systems are rapidly evolving, while at the same time the latest expertise is disseminated directly from conferences, congresses and symposia to the professional world in ever-faster cycles. This series of proceedings offers rapid access to this information, gathering the specific knowledge needed to keep up with cutting-edge advances in automotive technologies, employing the same systematic approach used at conferences and congresses and presenting it in print (available at Springer.com) and electronic (at Springer Link and Springer Professional) formats. The series addresses the needs of automotive engineers, motor design engineers and students looking for the latest expertise in connection with key questions in their field, while professors and instructors working in the areas of automotive and motor design engineering will also find summaries of industry events they weren't able to attend. The proceedings also offer valuable answers to the topical questions that concern assessors, researchers and developmental engineers in the automotive and supplier industry, as well as service providers.

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Johannes Liebl
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Vorwort

Die Mobilität der Zukunft ist gestaltbar! Das intelligente, vernetzte, elektrifizierte und automatisierte Fahrzeug stellt Designer, Fahrzeugentwickler, Werkstoffingenieure und Produktionsfachleute gleichermaßen vor neue Aufgaben, denn es eröffnet bei Karosserie, Fahrwerk, Antrieb und im Innenraum neue Freiheitsgrade und Konzepte. Diese erfordern den Einsatz innovativer Komponenten und Werkstoffverbindungen, die in der Produktion dann aber auch sicher, qualitativ hochwertig und kostengünstig auf die Straße gebracht werden müssen. Zudem hat die Entwicklung neuer Geschäftsmodelle einen maßgeblichen Einfluss – insbesondere auf den Ausbau der „Shared Society". Gestaltungskriterien zukünftiger Mobilitätslösungen sind nicht nur deren Sicherheit und Effizienz, sondern auch deren Nachhaltigkeit unter Berücksichtigung des kompletten Lebenszyklus. Der neue internationale Kongress wird gemeinsam von der fka GmbH und ATZlive veranstaltet. Er dient als Informations- sowie Kommunikationsplattform und beleuchtet sämtliche Facetten des Mobilitätswandels.
Wir freuen uns auf Ihre Teilnahme an der Tagung.

Für den Wissenschaftlichen Beirat
Dr. Alexander Heintzel Chefredakteur ATZ | MTZ-Gruppe, Springer Nature
Dr. Hubert Pelc Leitung Fachmedien Materials | Energies,
Konzepte – Werkstoffe – Springer Nature

Editorial

We can shape the mobility of tomorrow! The intelligent, connected, electric, automated car presents designers, vehicle developers, materials scientists and production specialists with new tasks, because it opens up new opportunities and allows for new concepts in areas such as the body, chassis, powertrain and interior. These require the use of innovative components and combinations of materials, which must produce safe, high-quality and cost-effective results. In addition, the development of new business models will be a major influence, particularly on the growth of the sharing society. Future mobility solutions must be designed with not only safety and efficiency in mind, but also sustainability from the perspective of the entire product life cycle. The new international congress will be jointly organized by the fka GmbH and ATZlive. It is an information and communication platform that highlights all aspects of the mobility transformation.
We look forward to welcoming you to the conference.

On behalf of the Scientific Advisory Board
Dr. Alexander Heintzel Editor-in-Chief ATZ | MTZ Group, Concepts – Materials – Springer Nature
Dr. Hubert Pelc Head of Specialist Media Materials | Energies, Springer Nature

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Keynote Speech
Disruption in mobility – new trends, new concepts and new business models?!

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Abstract. Technological progress based on digitalization and automation opens up opportunities for a variety of new mobility and vehicle concepts. Beside that, the way we use and understand mobility in modern society is underlying a drastic change. As a consequence, user-oriented mobility services with high flexibility are piloted and rolled out in urban areas. Within the article, we discuss different types of autonomous and shared concepts and their potentials in modern transport. Based on the use case of so-called Robocabs, results of an international user survey are presented with a strong focus on user acceptance. Furthermore, new mechanisms and models to generate additional revenues linked with the vehicle concept like new forms of advertisement are discussed. A data-driven analysis shows that there lies substantial revenue potential in value-added services, though the value distribution varies to a significant extend. Whereas static or recurring advertisement allows only for limited revenues, geo-located advertisement with tailored offers and context specific options for interacting with the customer hold the potential to multiply the average advertisement revenues.

Keywords: Mobility Concepts, Autonomous Driving, Business Models, Robocab, User Acceptance, Value-added Services

1 Introduction

Digitalization is changing our lives, our world of work and our industries at a rapid pace. Especially in the automotive industry, the so-called "digital transformation" is on everyone's lips. Automotive manufacturers (OEM) are more or less forced to completely rethink their products and services. Connectivity, electrification and automation of vehicles, as well as service-oriented mobility solutions, are the four main drivers.

The intelligent combination of these trends describes what is probably the most promising yet vague vision of the future automobile: Robocabs. It is obvious that self-driving, electric vehicles, which are no longer owned but booked on-demand via smartphone, will have an immense influence on our mobility system. In particular, today's heavily overloaded urban traffic could be optimised and made more sustainable. New user groups such as underaged or elderly might become individually mobile.

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What sounds like the future, has actually been in the focus of OEMs, software companies or suppliers for several years. Meanwhile in fact, this topic is part of the public discourse and arrived in our society. The media report at high frequency on new pilot projects, prototypes and innovative test tracks. Thus, autonomous driving is slowly becoming an interesting option for potential users, even though up to now direct contact with this technology is very limited. According to our research, a noticeable increase in the number of automated vehicles is to be expected by the next decade. The authors assume that 20 percent of new vehicle registrations in 2030 will be highly automated and 5 percent even fully automated or driverless [1]. Other current studies estimate the share of automated fleet vehicles with automation levels 4 and 5 at 12 to 20 percent in 2030 and 32 to 42 percent in 2035 [2, 3]. Depending on market penetration, high traffic impact potentials are forecasted for automated taxis and shared fleets of "Robocabs". Effects may be noticed in terms of a reduction of parking space, vehicle numbers and thus an improvement of traffic flow, or with regard to the transport costs of urban mobility [4, 5]. Robocabs can give new flexibility to public transport and provide an innovative alternative to existing mobility services.

However, it is largely unclear how these vehicles can be imagined and what expectations or reservations future customers have towards them. In our research, we have found that the view of these vehicles varies greatly depending on whether one is discussing with potential users, representatives of the automotive industry or transport operators. Various scientific studies and model calculations, which deal with the topic in more depth, also assume completely different vehicle concepts.

The question of how to imagine Robocabs and their less automated, preliminary stages from the user's point of view remains. What do potential users want? What are motivating factors and what are inhibiting factors? Which vehicle concepts are most suitable? User acceptance and social acceptance will play a decisive role in the success, distribution and selection of these new mobility systems. The difficulty lies in the fact that Robocabs are not on the market yet and therefore no fact-based findings have been generated so far. Application-oriented research and exploratory approaches are needed to assess the acceptance of the concept and to determine possible effects of Robocabs on transport and society.

On a second pillar, the question of new use cases and possible new business models in combination with the so-called RoboCabs arises. It becomes clear that this concept offers high flexibility and various degrees of freedom when it comes to its integration into existing mobility systems. Furthermore, the ongoing digitalization opens up for an almost unlimited variety of connectivity services, on demand solutions and new business models. Thus, it is not only about how future vehicle concepts and their uses cases might look like. The question is also how interwoven business models, specialized vehicles concepts and trip purposes will be.

2 Approach and Methods

The identification of trends, concepts and new business models within the field of new mobility requires a divers set of data, information and knowledge. While some of the

topics (e.g. trends) ask for an empirical, socio-scientific research approach, business models rely on computable data and information. Thus, our approach connects two different fields of research: User research and mobility simulations. Within this paper, we connect the already existing approaches and findings of [6] and [7] to highlight trends, concepts and the chances of new business models. The connection happens via the aim of both approaches to estimate a future mobility world. This happens by means of Across Method Triangulation.

Acceptance, perception and usage backgrounds with regard to shared, autonomous vehicles was investigated in the "Acceptance Study Robocab" [6]. It was realized by a mix of methods: On the one hand, it is based on a representative online survey in three countries (Germany, USA and China), and supplemented with qualitative in-depth interviews in Germany.

In addition to examining general usage parameters, the focus of the online survey is on the vehicle concept. A special approach within the survey is that the questionnaire design is based on a storytelling method. The aim is to introduce the respondents to the so far unknown product and the correspondingly unknown requirements with the help of questions in the form of an interactively designed imaginary trip. The respondents are asked to imagine what the Robocab looks like compared to conventional taxicabs. Expectations of the chassis, equipment or user interface are also raised. The quantitative survey thus serves primarily to generate a general mood picture of how a representative section of the population in the three countries imagines the Robocab. However, not only acceptance and usage background play an important role for the automotive industry. Expectations and images of the relevant target group are also important guidelines that should be taken into account in the development. The weakness of the method, however, lies in the standardised query, which leaves only a limited space for recording in-depth impressions or opinion formers.

A data-driven approach is conducted in [7] to investigate the possibility of new business models: It is examined to which extent commercials can subsidize Robocabs. Therefore, the revenues in total and per trip are estimated. The idea is to gather an understanding of possible business models: What is a trip worth in terms of passenger attention and how is this value distributed? The revenue comes from two sources: Commercials that target the vehicle's surrounding, like displays on the vehicle's roof (exterior ads), and the media that is displayed to the passengers (interior ads). Established advertising metrics are examined and a probabilistic revenue model is created to calculate the value of one individual passenger or a traffic participant paying attention to the vehicle's advertisement. The value of advertisement is modelled as the revenue, generated by the commercial or respectively the price the advertiser must pay for the passengers' or pedestrians' attention. The value of an advertisement campaign is dependent on a diverse set of factors: The number of viewers, how focused the customers can be addressed and how competitive the market for the advertised good or service is [8]. Thus, it is essential that a reliable database for all these measures is present.

Therefore, a fleet of autonomous taxis is simulated, based on real-world datasets about mobility demand and supply in New York City. The demand is modelled with the publicly available dataset of Yellow and Green Taxi Rides in March, April and May 2015. Traffic flows and route choices are reconstructed with an approach presented

in [9] and further developed in [7]. The trip purposes result by adapting the methodology of [10] to NYC. Thus, interior advertisement value can be calculated. The required variables to model the exterior commercials' revenue are the amount of pedestrians on each street segment and the surrounding land use. We derive the land use via points of interest from the OpenStreetMap API and the GeoNames API. Following [11], the number of pedestrians on each street is analyzed via the amount of geo-located Tweets.

To compare different effects, the value of taxi commercials is estimated under three distinct scenarios (see **Table 1**). The first scenario equals the present advertisement situation in NYC Cabs. The second and third scenario outline different future advertisement forms in Robocabs: With autonomous vehicles, the driving task does no longer tie the passengers up [12]. Additionally, connected, autonomous cabs have far more information than today's vehicles. Thus, they are allowed to display context-specific and targeted forms of advertisement (scenario 2). For example, the advertisement for a new running shoe could be displayed if the vehicle drives past a sports shop and knows that the passenger is heading for jogging. Going even further, passengers might just tell the Robocab, that they want to go shopping for a certain item. The taxi then drops the people at a suited shopping location. The Robocab operator receives a financial reward from the shop owner in return. This type of advertisement is called affiliate marketing (scenario 3). Insights about internet advertisement behavior help the formulation of a probabilistic model of the passengers' behavior in this case. For further insights on the methodology, please refer to [7].

Table 1. Three distinct scenarios represent future advertisement possibilities in Robocabs.

Scenario	Exterior Advertisement	Interior Advertisement
Scenario 1 (conservative)	– Static image on the vehicle's roof – Fixed pricing	– TV program with 30 seconds commercial break every 3 minutes – Fix price for a time period
Scenario 2 (a productive ride)	– *Same as Scenario 1*	– Passengers use electronic, in-vehicle devices to work or browse the internet – Banner advertisement is priced based on interaction an context
Scenario 3 (car as an interface to the city)	– Geo-located advertisement is displayed to the surrounding pedestrians – Dynamic pricing	– Passengers receive information about the environment and can make reservation, place orders, … – Pricing is bound to the action of the passengers

3 Findings

The previous introduction on autonomous driving and new mobility systems in the automotive sector already mentions that in future, there will be no ideal, stereotypical vehicle concept for Robocabs. Instead, it can be assumed that different interest groups

such as OEMs, operators and users will each pursue their own goals. However, there are some similarities among the different research vehicles and concept studies.

The results of the study presented in [6] show that potential users of autonomous mobility on demand – or Robocabs – are open-minded and generally interested in the concept. Contrary to initial expectations however, no ideal vehicle type of the Robocab can be identified (see **Fig. 1**). Individual requirements for vehicle characteristics, body and equipment change with the respective application and purpose. An autonomous vehicle is not understood as prestige object, but as reliable and fast means of transport. The results recommend its use in urban areas rather than for long distance rides. However, rural peripheral areas should be integrated into the line network in order to offer older and immobile people an attractive alternative to taxis or public transport. In this way, the problem of unprofitable bus routes can also be tackled.

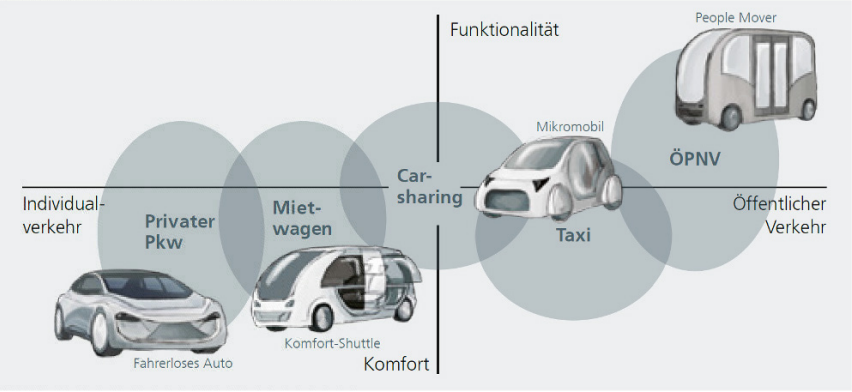

Fig. 1. Positioning of different mobility concepts on the basis of vehicle use and functionality [6]

The results predict a high level of acceptance for the so-called "comfort shuttle". These vehicle concepts, which tend to be large, high-quality but purpose-oriented, can be used efficiently in public sharing models. Additionally, sharing has a positive effect on the advertisement revenue, which can be generated during the trip. While advertisement revenues in the best scenario (Scenario 3) can only finance 5.56% of a Robocab trip with an average utilization of one passenger, this amount doubles if the car is used by three people. The average advertisement revenue is somewhere in between 0.27$ per trip (Scenario 1) and 0.81$ per trip (Scenario 3) [7]. In general targeted interior advertisement is much more valuable (0.55$ per trip, Scenario 2 to 0.70$ per trip, Scenario 3) than exterior advertisement (0.08$ per trip) and commercials that are not targeted at all (0.19$ per trip, Scenario 1 and 2). In general, advertisement can only contribute little to finance cab rides. However, there are few, very valuable trips for certain kind of affluent customers [7].

The comfort shuttle is of particular interest to those who have so far been unable to take advantage of public transport, for example due to a lack of comfort and privacy. They could use such a Robocab instead of their private vehicle. However, it is not yet

clear whether the Robocab will be used as a substitute or as a supplement to existing services. This aspect encounters diverging opinions and can possibly only be assessed in the actual implementation phase. Early adopters are identified as a relevant target group who, due to their affinity for innovation and technology, have a high interest in using the technology. While these early users act as opinion leaders and role models, the majority of those surveyed would initially observe the Robocabs from a distanced stance and, after a great deal of reflection and conviction, move on to use them.

The reason for this skepticism lies in existing safety concerns. In addition to technical fears, for example of hacker attacks or the independence of the vehicle, foreign passengers also trigger ambivalent associations. While some see the sharing option as an opportunity to make contact with others, others fear violent attacks and the loss of their privacy. For this reason, many people reject the Robocab as a transport option for children in particular. Safety-relevant components, such as safety belts, cameras or emergency switches, therefore become highly relevant to ensure confidence.

In addition to an expansion of the mobility offer, the respondents see the elimination of the search for a parking space, flexibility and permanent availability as the most convincing factors of the Robocab. In the opinion of the respondents, the use of the Robocab also goes hand in hand with increased emission efficiency and environmental friendliness, as users understand that these are always electrified drive concepts that are equipped with simple batteries and infrastructures, especially on short journeys. Before they can be used, however, it is necessary to clarify who will be the supplier of the Robocab concept in the future and to what extent ethical, legal and insurance issues still need to be regulated on the institutional side.

Additionally, prices for such public autonomous transport models are of importance. The difference in annual income between households in the bottom 20 percent and those in the top 20 percent grew steadily for almost all urban areas in the US [13]. Thus, social sustainability is of crucial importance to have these new forms of urban mobility accessible for everyone. However, the advertisement scenario with the highest income is also the one, which focuses the least on social sustainability: Affiliate marketing trips are of high value. In case of differentiated subsidization, households with greater purchasing power will profit. This insight is of general importance. [7] shows, that the less advertisement targets affluent passengers, the less it is worth. The distribution of advertisement revenue is thus of crucial importance from a governance perspective. However, the presented business models need to be enabled through technology. Trip purpose recognition, maps with information about shops close by, navigation by valuable roads and a market place for advertisement in Robocabs are necessary. Thus, not only the driving technology itself is of relevance, but also the surrounding ecosystem, enabling the new business models.

4 Discussion of Results

The findings clearly indicate that current vehicle concepts have to be rethought in order to succeed in the future. The trend of autonomous driving changes in-car pastime and creates new opportunities for business models within and around the car. The expert