The innovator's dilemma of the automotive industry: what if?

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The automotive industry is a sector which has tremendous importance in many national economies today. Automotive is a huge employer, tax payer and relevant for economic growth. It is moreover a highly innovative sector which spends, for example in Germany, about 40 percent of the national R&D expenditure (Bormann et al. 2018). At least, road based mobility for private and commercial purposes is highly dependent on cars, trucks, road infrastructure quality etc. The mobility paradigm today, culture, location choice, leisure activities, trade, economic exchange is based on automotive. Since a century, according to Geels (2005) since Ford`s T-model provided the dominant design of a car available for the middle class society, a socio-technical system established. The socio-technical system consists of technology, user practices, application areas (markets), symbolic significance of technology, infrastructure, industry structure, politics and scientific knowledge (Geels 2002). The importance and power of the automotive industry today, is thus not only technical or economic or social but fused systematically in economic and social development.

However, great challenges put some pressure on the automotive industry. Bormann et al. (2018) summarize (1) Digitization: the exponential dynamic by information and communication technologies change everything from technological opportunities and business models to markets rules and user culture. Freeman and Perez (1988) speak of a new socio-economic paradigm by digitalization technologies. (2) Sustainability: the increasing requirement to reduce or even neglect external effects by automotive mobility such as pollution, emission, resource consumption and fatalities. (3) Urbanization: the growth of population, the agglomeration of people in cities and a new movement of rural exodus is a worldwide trend which becomes an increasing challenge as far mobility in cities is based on road vehicles. (4) Individualization: this fourth and last major challenge is that collective expectations and behavior turns into individualism not only in terms of transportation but also in terms of goods and goods consumption, personal development and lifestyle. The more developed a society is the more complex, flexible and variable demand becomes.

To tackle these challenges and to develop the business accordingly the automotive industry intensifies efforts in three major innovation activities: (1): Automation of driving: the driver assistant systems developed in the last two decades should in the near future be able to take over the driving task. It is commonly argued that automation can increase infrastructure capacity, access to auto mobility, save fuel consumption and enhance safety (2) Mobility as a Service: to own a car, in particular in urban context, is becoming less attractive for a growing number of people. To serve mobility demand those people use sharing and pay per use concepts, not only limited to cars but including all modes and means such as cars, bikes, scooter and public transport. (3) Electro mobility and alternative fuels: the internal combustion engine produces much of the external effects of automotive mobility. High political and social efforts challenge the internal combustion engine and favor alternatives such as electric drives, gas or hydrogen. A growing number of restrictions such as limited access to city area and emission standards in line with innovation funding programs do drive the change in the automotive sector.

Bringing together challenges and approaches of solutions, it is commonly accepted that a revolution in mobility is envisioned and pursued. However, is this future already expression of the so called

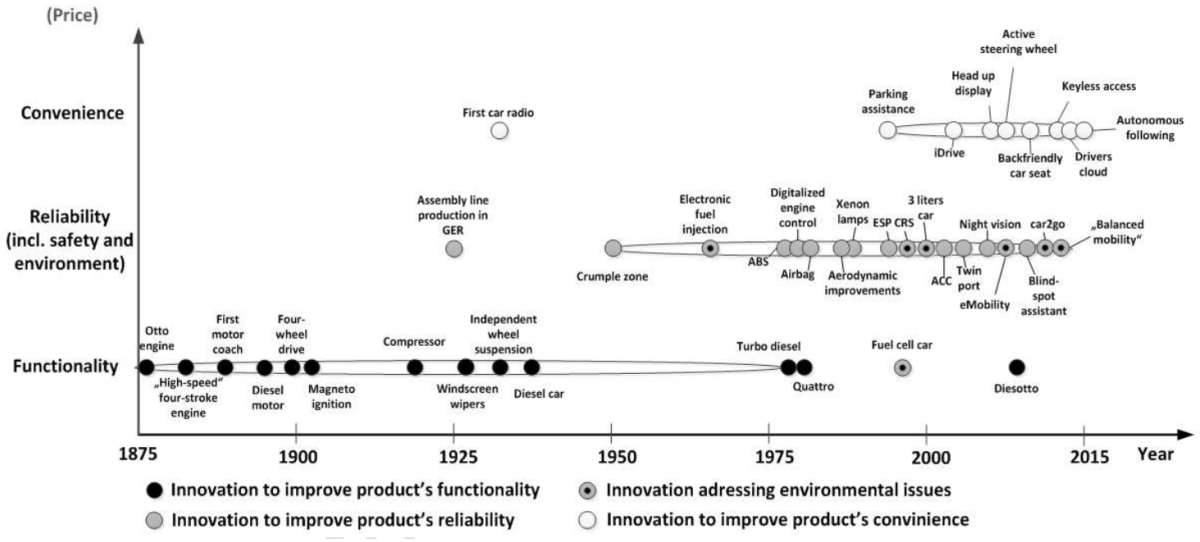
innovator`s dilemma and thus not the overall answer of future mobility? One of the consequences of the innovator's dilemma is that, although the business development appears advanced and consistent, big firms develop towards failure (Christensen 1997b). Against this background this paper investigates the possibility of the innovator's dilemma for the automotive industry and discusses the policy implications if the innovator's dilemma is existent.

The innovator's dilemma consists of two main elements: Firstly the pattern of innovation competition and secondly from the overshooting of demand in the conviction that the intensification of the core product is geared to the needs of core users. Christensen (1997a) examined the innovation competition pattern between companies that started to produce disruptive technologies. The companies' product competition is then typically structured as follows: First the functionality of products is the core of the innovation competition. Due to the competition products become homogeneous in functionality. The innovation competition concentrates then on reliability of products. After products become homogeneous in reliability the innovation competition focusses on convenience of the products. In the innovation competition products are then homogenous in functionality, reliability and convenience and can thus the price becomes the selling point for customs. Christensen further describes that these competitive phases create a disharmony between competing companies and customer requirements. This is due to the fact that changing conditions create new requirements for products that are not taken into account in the phases of innovation competition. Christensen speaks of an effect of this competition, the "overshoot demand", which is due to the fact that competing companies do not gear product development to the new customer needs, but try to use all technological possibilities to gain competitive advantages in the mass market. "Successful companies tend to develop a bias for predictability and stability; they work on defending what they have." (Porter 1990) and "failing companies tend to be remarkably creative in defending their entrenched technologies, which often reach unimagined heights of elegance in design and technical performance only when their demise is clearly predictable." (Utterback 2004). The innovator's dilemma describes a switch of economic decision: to invest in sustaining innovation on the established technology or to invest in disruptive innovations. Although economic reasonable is the first, the second prevails for companies sure market failure. Hence the innovator's dilemma enforces to "do the economically wrong thing" for future market success.

The pattern of the innovation competition is based on four characteristics as the basis of the competition: 1) functionality, 2) reliability, 3) comfort and 4) price. In order to demonstrate this pattern, we have evaluated important innovations of the automotive industry in their lifetime. These innovations are selected by the VDA (German Association of the Automotive Industry), which represents the industry at national and international level. The VDA published a time line "Technological innovations of the last 130 years" (VDA 2013) and described the core of innovation for the year. In some cases, the assignment could not be made uniquely. The environmental issue in particular, to which the VDA refers in some of the innovations, made this difficult. For example, digital engine control increases engine reliability until 1979, but also improves the coordination of combustion processes, which ultimately makes the engine more efficient. This efficiency is highlighted by the VDA as an environmental innovation. Labuzinski (2018) therefore examined whether a dimension of the "environment" should be included in the innovation pattern. He concluded that environmental innovations reflect the pressure on industry to act, but not the basis of competition. The figure below shows the innovations of 130 years in the timeline with reference to one of the four phases of product competition. In black the

level of functionality, in gray and grey/black dotted the level of reliability and in white the level of comfort are depict. Price competition cannot be designed through product innovation and is therefore excluded from analysis.

What we can clearly see in the figure is a sample of product competition in accordance with Christensen's proposed levels. The car's basic functionality (four wheels, four seats, internal combustion engine, engine in the front, trunk in the rear etc.) was the core of innovation competition until World War II. The product innovation on reliability (including safety and environmental issues) was the core of competition from 1950 until the 1990s. But then comfort/convenience became the dominant goal of competition when cars were of similar functionality and reliability. "Premium vehicles made in Germany" became a product label for German original equipment manufacturers and the competition for technical and design elements began to make the vehicle more comfortable for users. Today's hype about autonomous driving and Mobility as a Service can directly be linked to the most comfortable car for the user, where he/she no longer has to drive but individual mobility is maintained.



Briefly, the implication of the innovator's dilemma for automotive industry is the danger of a price competition for homogeneous goods (automated cars and cars in mobility services). It is not only a barrier for future innovativeness but also implies a danger by disruptive transportation technologies, which clearly addresses emerging requirements by users in current niche markets. The brief policy implication is that it is worth to investigate automated driving as technology which tends to overshoot the demand. That might mean a need to support disruptive transportation technologies and not only measures limited to the technical performance of the established.

Keywords: innovation competition, automotive, transport system's evolution