Sketching the Future of Mobility with Visualizations

When conducting foresight research on disruptive innovations, visualizations are a powerful tool to generate customer insights, communicate findings and buy-in internal stakeholders. This paper demonstrates the successful application of visualizations in a consumer-centric foresight study on the future of self-driving cars.

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Schwerpunkt **Innovative Ideen generieren**

In order to remain competitive, companies struggle with a continuous search for new opportunities (Eisenhardt & Martin, 2000; Teece, Pisano & Shuen, 1997). Sometimes, firms are required to react rapidly to radical developments (Brown & Eisenhardt, 1997; Gersick, 1991; Levinthal, 1992). Firms that are unable to anticipate changes or to design countervailing strategies may end up in precarious situations (Christensen, 1997; Day & Schoemaker, 2004; Stubbart & Knight, 2006). Especially radical innovations challenge the entire industry ecosystem and fundamentally reorder well-established patterns (Tushman & Anderson, 1986; Tushman & O'Reilly, 1997; Van de Ven et al., 1999, p. 171). Such innovations often embody a new technology and result in discontinuities on a macro and micro level (Garcia & Calantone, 2002). However, many innovations are rejected regardless of compelling features (Garcia, & Atkin, 2007; Molesworth & Suortti, 2002), due to a missing link to consumers' needs (Kleijnen, Lee, & Wetzels, 2009).

Understanding which adaptations have to be made to a company's strategy to face uncertainties and to comply with customer expectations and which opportunities arise in the face of new developments is of major importance for a company's survival (Paap & Katz, 2004). One way of doing this is to establish customer-oriented foresight research as a fundamental element of business strategy (Kleijnen et al., 2009; Rohrbeck & Gemünden, 2011; Roveda & Vecchiato, 2006).

This article introduces a case of innovative foresight implemented in the automotive industry, which aimed at anticipating the future of self-driving cars with the help of profound customer insights. Thereby, visualizations enhanced generation, interpretation, and communication of data. The article shall demonstrate with examples how visual communication drives the success of foresight research on disruptive innovations. After introducing the theoretical background and general study framework, the author outlines two empirical studies and explains different functions of visualizations in foresight. Implications will be drawn for practice.

1. THEORETICAL BACKGROUND

1.1. Strategic Foresight

One of the most challenging tasks for managers is to understand what the future holds and to strategically plan ahead. The increasing complexity and interaction of economic, social and competitive factors tend to be cognitively, socially, and emotionally demanding (Eppler & Burkhard, 2007). This is where systematic foresight research comes into play. According to Miles, Keenan, and Kaivo-Oja (2003), foresight describes research activities which provide inputs about an organization's long-term future. Strategic foresight deals with the future 10 or more years ahead. It enables the detection of weak signals in the immediate and extended environment, new trends, as well as opportunities (Coates, 2010) and thereby, helps to address problems early. Thorough strategic foresight has the power to enhance a firm's decision-making process as well as to motivate internal stakeholders with a bold, aspirational vision (Bezold, 2010).

One way of approaching upcoming changes with foresight is by developing scenarios of alternate futures and the world external to an organization (Ringland, 2010). Scenarios help to anticipate how changes in the expression and interaction of different factors, as

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well as the joint impact of multiple uncertainties, influence the future (Bezold, 2010; Schoemaker, 1995). The use of scenarios is valuable to contextualize different ideas. They simplify available data through sense-making processes such as consistent and inspiring storytelling (Brown, 2009) and can thereby inform and engage internal stakeholders (Ringland, 2010). Visualizations play an important role in the design of scenarios (Bezold, 2010).

1.2. Visualizations

Various formats of visualizations exist, such as graphs, diagrams, photographs, schemata, maps, cartoons, and videos. Research has shown that images are more easily processed, understood and memorized by the human brain than text (Clark and Paivio, 1991; Paivio, 1986; Park, Puglisi, & Sovacool, 1983). They are part of the thought process and help to tell stories by triggering imagination and by summarizing complex situations (Ottino, 2003). In the communication with others, visualizations support knowledge management, e.g. by establishing mutual understanding of concepts (Müller & Shwarz, 2016). Furthermore, they are of value in different process stages of strategy making, by addressing diverse cognitive (e.g. information overload), social (e.g. coordinating multiple hierarchic levels) and emotional (e.g. creating involvement and engagement of the staff) challenges (Eppler & Platts, 2009).

Also in the context of foresight research visualizations have proven to be very helpful (Müller & Shwarz, 2016). Heinonen and Hiltunen (2012) demonstrated that the use of visual images enhances creativity in the development of visionary ideas, arguing that there is "a reciprocal and reinforcing relationship between creativity and innovation" – one spurting the other. In combination with scenarios of possible futures, visualizations provide images to the narratives. Therewith, visualizations facilitate synthesis of information and ultimately comprehension of challenging content by reducing cognitive overload (Eppler & Platts 2009). According to dual coding theory, images also improve learning and recall of such narratives. This results from information being processed in brain areas responsible for interpreting visual in addition to written input (Clark and Paivio, 1991; Paivio, 1986). Lastly, research has shown that visualizations, especially surprising or shocking images, make written reports more emotional (Heinonen & Hiltunen, 2012; Müller & Shwarz, 2016) and thereby increase engagement in a topic (Bezold, 2010). The main functions of visualizations in foresight research are:

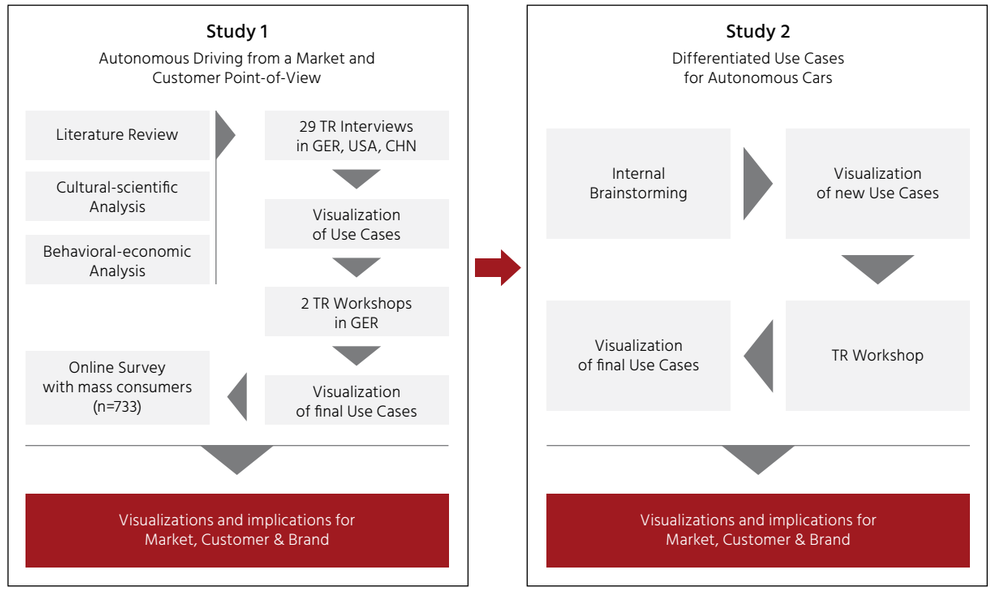
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- Enhancing creativity: By making complex topics more tangible (Baerten, 2007), visual communication supports creative thinking. Inspiring visualizations boost imagery, allow for changes in perspective and enable innovation (Heinonen & Hiltunen, 2012).
- Establishing Understanding: Visualizations function as a common denominator. By constructing and conveying insights for shared conversations and mutual understanding, they provide an important social benefit (Eppler & Platts, 2009).
- Managing complexity: Images help to effectively manage complexity and cognitive overload (Eppler & Platts, 2009). By compressing and synthesizing information, they are valuable on a cognitive level.
- Generating Insights: Visualizations combine multiple perspectives and can depict concepts and patterns. Therewith, visualizations lead to new and innovative insights (Heinonen & Hiltunen, 2012; Müller & Shwarz, 2016).
- Transferring Knowledge: Visualizations allow for the transfer of knowledge at many levels (Müller & Shwarz, 2016). Complex information can be communicated more easily and successfully with visual communication than with text (Park et al., 1983).
- Encouraging engagement: Visualizations increase involvement of stakeholders on an emotional level. The use of inspiring images in communication can motivate and buy-in recipients (Bezold, 2010; Eppler & Platts, 2009; Müller & Shwarz, 2016).

Management Summary

Visualizations are a valuable support in foresight research on disruptive innovations. This article introduces a consumer-oriented case study on the future of self-driving cars. It describes how an iterative development of visualizations supports the generation of profound and valid customer insights, interpretation of data and communication of findings to stakeholders.

Fig. 1: Depiction of Research Designs of Study 1 and 2.



TR = Trend Receivers. Source: Own diagram.

Fotos: Unternehmen

Within this consumer-centric foresight study, visual images were employed and developed in the context of the disruptive innovation of self-driving cars. Visualizations helped to explore the automotive future, supported visual storytelling and the buy-in of the management board by condensing complex customer insights into single images. The following case study will provide details on the function and value of visualizations in this automotive industry project.

2. CASE STUDY: Challenges of Autonomous Driving for the Market and Customer

The advent of self-driving vehicles and the radical nature of this development contribute to a rapidly evolving automotive industry, characterized by a high degree of complexity and uncertainty. In 2015 and 2016, two customer-centric foresight studies were implemented in cooperation with an established German car manufacturer. The aim of the studies was to systematically explore and sketch possible futures and business opportunities evolving in the face of autonomous driving. In order to account for multiple perspectives, the research team relied on a multi-methodological research design that combined qualitative and quantitative approaches (Figure 1). Ultimately, the generated insights resulted in visualized scenarios for semi-[1] and fully automated driving[2]. Visualizations were developed iteratively with the support of customers to provide consistent images of a possible automotive future.

[1] **Semi-automated cars:** Vehicles which can monitor the driving environment and are in control of the driving task only in specific traffic situations (SAE International, 2014).
[2] **Fully automated cars:** Cars which take over the entire driving task in all situations.

Fig. 2: Discussion and Editing of Preliminary Sketches of Automated Cars in TR Workshops



Left and right: Preliminary sketches of first thoughts on semi- and fully automated cars, respectively. Middle: Workshops, working with preliminary sketches. The sketches were further developed and used as discussion material during trend receiver workshops.

Source: AUDI Trend Research, illustrations developed in cooperation with Hyve AG.

2.1. Study 1: Autonomous Driving from a Market and Customer Point-of-View

Research Design

An extensive literature review combined with a cultural-scientific and a behavioural-economic analysis provided the basis for a series of interviews with trend receivers in Germany, the USA, and China. Trend receivers (TR) are visionary customers who perceive changes and potentials in a specific domain in a highly sensitive and differentiated way (Hofmann, 2015). Qualitative insights from the interviews were sketched and transferred into visualized scenarios which were discussed and further developed in two consecutive workshops with German TR. Graphic designers professionally visualized three final scenarios for semi- and fully automated cars. Subsequently, a quantitative online survey with 733 customers from the same three countries validated the visualizations for semi-automated driving. Insights and visualizations resulted in a video on autonomous driving as well as a report for internal stakeholders.

Use and Function of Visualizations in Study 1

Enhancing creativity. TR interviews covered current mobility behavior, as well as visions of semi- and fully autonomous driving in 2020 and 2025, respectively. For the interviews, visual stimuli of the technology were chosen on basis of the literature review to facilitate understanding and imagination of this radical technology. Those images helped to inspire creative thought processes and enabled an open space for concretizing an aspirational future of mobility. Individual user journeys played a major role in creating this vision of future mobility and laid the groundwork for sketching specific scenarios.

Managing complexity. Interviews were transcribed verbatim, then coded, and analyzed via qualitative content analysis (Krippendorff, 2004). The vast amount of qualitative data was condensed, translated and visualized in form of preliminary sketches for semi- and fully automated cars. In this research stage, visualizations supported the structure, synthesis and interpretation of the data, while avoiding information overload. Complex insights were integrated into comprehensible images of future cars. The research team identified relevant examples of product use (e.g. entertainment), advantages (e.g. productivity) and requirements for exterior and interior design.

Lessons Learned

In the context of foresight research on highly disruptive innovations, visualizations play a supportive role throughout the entire research process. They help to stimulate creative thoughts, manage complexity, generate customer insights, enable mutual understanding, transfer knowledge, encourage engagement of stakeholders and validate findings. Especially the iterative development of visualizations together with visionary customers is valuable in sketching alternate futures in a given field.

Generating Insights. Systematic content analysis and the parallel development of visualizations led to the detection of patterns within the TRs' statements and greatly assisted the team in drawing inferences from the data.

During the workshops, preliminary sketches (Figure 2) improved insight generation by allowing TR to take new perspectives and by triggering an authentic experience of the future (Baerten, 2007; Müller & Shwarz, 2016). Workshop members iteratively adapted the drawings during discussions according to upcoming insights. Participants were able to take a deep-dive into the wide possibilities of the technology and to imagine completely new usage scenarios for automated cars.

Fig. 3: Final Visualized Scenarios for Fully Automated Cars (Study 1)





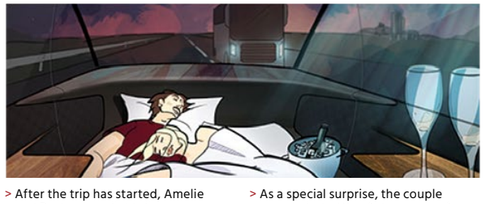
Fully autonomous driving: Market and customer

The car as hotel room.



> Amelie and Paul are driving to Austria with the autonomous car to go skiing – the first trip of the young couple

> Amelie checks the snow height again and reserves a table at a recommended restaurant for the following night



> After the trip has started, Amelie and Paul enjoy a light dinner

> Beforehand, the car had picked up the dinner at their favorite restaurant

> As a special surprise, the couple received a bottle of champagne from the restaurant

> After dinner and an episode of their favorite TV series, the couple falls asleep until arriving in the mountains



> Amelie and Paul are excited about the panorama upon their arrival while enjoying a coffee from the espresso machine

> In the distance, they recognize the lounge of their car manufacturer

> In the lounge – their first stop at their destination – they want to have breakfast and they find all amentities to start a day on the pistes

a. Relaxing between meetings, b. More family time, c. Relaxed to a holiday destination including short narrative

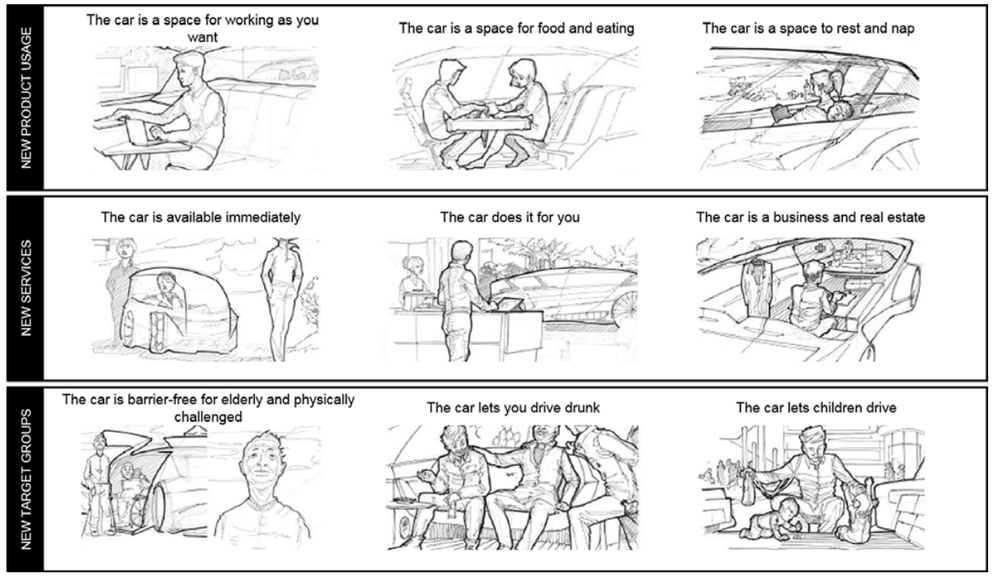
Source: AUDI Trend Research, illustrations developed in cooperation with Hyve AG.

Establishing Understanding. The visualized scenarios aligned different perspectives within the research team and formed a consistent idea of the topic and findings. Visualizing the content assured mutual understanding with the TR sample during the workshops as well as inside the research team.

Validating Findings. The preliminary visualizations introduced to and developed during TR workshops also served the purpose of validating interpretations. They were systematically structured, discussed, discarded and fine-tuned by means of individual and group work as well as plenum discussions. This process ensured that the drawn inferences and visualizations captured the most salient customer expectations and needs. Moreover, the iterative process of constructing and deconstructing made the development of consistent images of the future easier. By means of an extensive quantitative online survey, the findings on semi-autonomous cars were further validated with mainstream consumers. Visualizations of the three most important use cases were shown to 733 consumers who then had to indicate their preference. Every use case was chosen by at least one fourth of the sample, indicating high approval of the visualized insights.

Transferring Knowledge. The drawn images ultimately helped to organize the data into final visualized scenarios which eased understanding of the content compared to great volumes of simultaneous insights. This also allowed for an effective communication of study results and thereby made their integration into the strategic planning of the firm more likely. As shown in Figure 3, the images reveal a plethora of innovative insights. For example, the scenarios suggest an adaptation of the car's interior to consumer needs, such that people can engage in new side-activities in automated cars. The findings and images were summarized in a report and in a video on autonomous driving for the management board. Within the final study report, the developed

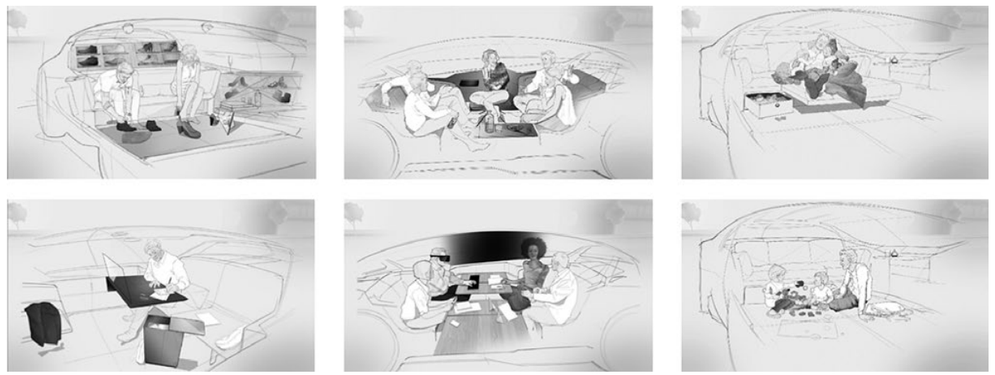
Fig. 4: Preliminary Visualizations of New Product Usage for Fully Automated Cars as Input for the TR Workshops in Study 2



Source: AUDI Trend Research, illustrations developed in cooperation with gravity GmbH.

Fig. 5: Examples of Final Visualizations of New Use Cases for Fully Automated Cars (Study 2)

e.g. top left: the car as retail space; lower left: the car as an office; lower right: the car as extended living room for family time.



Source: AUDI Trend Research, illustrations developed in cooperation with gravity GmbH.

visualizations underlined the innovation's radical nature and mapped out emerging business opportunities.

Encouraging Engagement. The visualizations in the final report capture the richness and range of customer insights generated in the interviews and workshops. They stimulated decision makers to consider the suggested changes and challenged their prevailing mindset. Together with the report of the main findings, the carefully developed visualizations motivated the management board to support subsequent studies and to distribute the findings to a wider audience.

2.2. Study 2: Differentiated Use Cases for Autonomous Cars

Research Design

After an iterative analysis of the findings of study 1, the research team visualized more differentiated use cases for fully automated cars. These use cases were evaluated, rated and adjusted in a workshop with 6 TR in Germany by means of group discussions and individual working tasks. On the basis of the workshop insights, the research team visualized final use cases. Study 2 allowed for further in-depth exploration of the automotive future by identifying necessary changes to the exterior and interior design, customer-oriented services and business opportunities in the face of full automation.

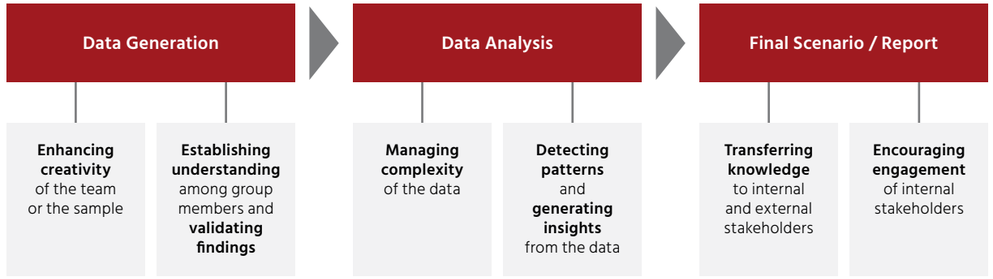
Functions of Visualizations in Study 2

Again, visualizations helped to transfer the previously generated insights to the TR sample, to trigger creative thought processes within the group and thereby to successfully collect further customer insights during the workshops. They also ensured that the TR discussed the use cases on basis of a mutual understanding. Lastly, the images were valuable in convincing internal stakeholders of changing mobility concepts. For example, the board of management communicated the study insights to an external audience at symposiums and press conferences. Extracts of preliminary and final visualized usage scenarios are depicted in Figure 4 and 5, respectively. The images underline, that the role and design of future cars are about to change dramatically. Figure 6 depicts how visualizations support the different phases of the foresight research process.

3. DISCUSSION

This article emphasizes the benefit of visualizations in consumer-centric foresight on disruptive innovations by describing how they were used in two case studies on autonomous driving. The presented case studies were embedded in a multi-methodological re-

Fig. 6: Functions of Visualizations Throughout the Foresight Research Process



Source: Own diagram.

search project and conducted in cooperation with an established German car manufacturer. Visualizations served as a helpful tool throughout the entire foresight research process and supported the generation of profound, consumer-driven insights on this radical innovation. The paper describes how visualizations can be employed and developed at different project stages to stimulate creative thought processes of consumers, manage complexity, generate customer insights, enable mutual understanding of the topic, transfer knowledge, as well as to encourage engagement of the management board. Moreover, the author outlines how visualizations help to validate inferences that were drawn from the data.

The conducted case studies underline that an iterative development of visualizations makes them more powerful and ensures that the images are consistent with and representative of customer needs and expectations. In addition, a continuous dialogue with consumers and an interdisciplinary team guarantee that multiple facets and perspectives are taken into account in the design of visualizations. Also within this research project, visualizations of scenarios for semi- and fully automated cars were developed with the help of an iterative process and a continuous dialogue with future-oriented customers (i.e. trend receivers). Ultimately, visionary, customer-centric images were sketched with wide-ranging impact on strategic planning and engagement of internal stakeholders.

However, visualizations never represent every single insight. In this study, for example, the visualized scenarios depict an aspirational rather than a threatening future. While addressing advantages of the technology, potential downsides such as customer worries or overall industry threats, are not captured by the images. Research teams can account for this limitation by combining images with written narratives and a complete report on the results.

The two case studies confirm recent insights from Müller and Shwarz (2016) as well as from Heinonen and Hiltunen (2012) on the importance of visual communication in foresight research and extend the findings to the realm of highly disruptive innovations. The studies serve as an example of how the use and development of visualizations support managers in anticipating the future of such disruptive innovations. This approach does not only stimulate the creativity of team members and samples, which is necessary for envisioning alternative and radical possibilities of disruptive innovations. Visualizations are also valuable in managing and communicating a complex plethora of socio-economic, social and competitive factors and in gaining support from relevant stakeholders.

Main Propositions

1. Develop images iteratively during customer workshops to stimulate creativity.
2. Employ visualizations as discussion material to ensure mutual understanding and to validate customer insights.
3. Sketch visualizations during insight generation to structure complex data and to detect patterns and trends.
4. Break complex narratives into single, comprehensible images and integrate them into the report of findings to improve communication.
5. Develop emotional and inspiring visualizations of possible futures to engage stakeholders.

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