

Can data produced by advanced cars be used to improve the design of a car or its parts?

ABSTRACT

This paper is an exploratory research dealing with whether designers can use data produced by advanced cars to improve the design or the system around cars. It explores the current scenario and the kind of data produced by cars and what it is being used for at present. Then it poses questions on how and whether designers can use such data to improve the functionalities of a car. Interviews with experts in the field were conducted and a symposium on the Future of Driving was attended in order to gain more insight on this topic. It was found that there is indeed a role for designers in using data generated by cars to improve the design of a car. At present, such data is being used in order to improve the seats and user's posture. In the future, there is a lot of scope for designers to use sensor generated data to improve the wellbeing and overall experience of a driver in the car.

Keywords

Cars, sensors, data driven design, driver, experience

INTRODUCTION

In the age of smart cities, smart phones, smart everything, the automobile industry is also moving towards smart technologies that steer more sustainable and efficient cars. From gas to hybrid to fully electric cars, we have come a long way. Current generation cars are equipped with a lot of sensors to measure various elements like temperature, pressure, driving patterns. These sensors constantly generate a lot of data. Such data is currently being used in order to determine and improve overall performance of cars. Cars have sensors that absorb data and give drivers and infrastructures information about navigation, pollution control and traffic management (Mario Gerla 2014). The system around cars is constantly evolving in the inter-vehicular communication aspect, and the entire system is becoming an internet of things. But at the moment, most of the data that is generated is being used for engineering purposes. This paper will explore the prospects of such data from a design perspective. Can designers use such data to improve a unit of the vehicle or enhance user experience?

REVIEW

At present, data generated by cars are through sensors and navigation systems. They are being used to predict traffic, infrastructural hindrances and driving behaviour. Schäfer, proposed a system where real time data of cars is used for traffic predictions. Data collected via GPS (Global Positioning System) of taxis were sent to the taxi headquarters thus producing a nearly complete data

coverage of all major roads. (2012) But is limited research in the field of designing with data generated by cars.

A study conducted by 207 BMW employees in determining automatic adjustment of a car's driving mode versus manual proved that users were more comfortable with automatic adjustment. In this experiment, the driving patterns and emotions of the users were studied. Based on that, the cars were made to adjust in order to see if it influenced the "Flow experience" using the car (See Fig 1).

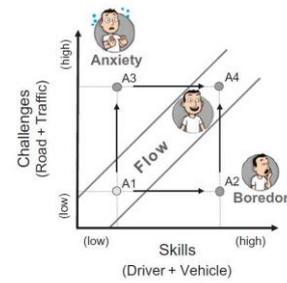


Figure 1. Flow diagram and PrEmo applied to driving. (Csikszentmihalyi, 1987; Desmet et al., 2007)

This project involved gathering the driving style of the user and altering driving nature in order to enhance the driver experience (Russ, 2016).

Another instance where data has been used to enhance user experience currently is in the BMW 7 series. The BMW 7 series has a sensing system on the backrest, to play a game on the rear seat (See Fig 2). You can play a game by pushing the air chambers and the changing pressure is recorded. Based on that the game progresses. It has already been implemented in the car. It is called the vitalization seat. It helps flex all the muscles in your body after long hours of being seated, without having to get out of the car (See Fig 3). The pressure distribution data of various parts of your body is collected and the instructions in the game are according to that.



Figure 2. The new revitalizing game in the BMW 7 series.
Photograph: Lukas Riede, 2016



Figure 3. Student testing out the game by moving different parts of the body while seated.
Photograph: Lukas Riede, 2016

Although this uses data to adjust to user needs, this is only an extra element of the car and is not generic. Such features are specific to cars. I would like to focus on the more generic data that is produced, and not just by a certain extra element of the car.

In this paper, I would like to pose and hopefully find the answers for the following questions:

1. What kind of data do designers currently require while improving the design of a car?
2. What aspects of the car could be improved in terms of design, with the data generated by the cars?
3. Can the data produced by the sensors on the car be used to design or improve a particular aspect of a car?
4. To what extent was there a difference in designing with data versus designing based on user testing?
5. To what extent would using data hinder or influence a designer's decision?

METHOD

Interview

Since designing and improving vehicles with data generated by them is not available widely in practice, online interviews with expert who have been working in this field was conducted in order to gain information relating to this. The following people were interviewed.

1. Dr.ir. Perter Vink, Head of Design Engineering, faculty of IDE, TU Delft was interviewed for his experience working on BMW's seats.
2. Dr.ir. Riender Happee Assistant Professor 3ME, TU Delft, who is currently coordinating the WEPods, a project on small automated cars.
3. Ms. Alicia Calderon, graduate student at TU Delft who has worked with Volkswagen for her Joint Master Project was contacted regarding this. JMP, is a semester long group project with students from different design masters working together on a project. Alicia did her Joint Master Project with Volkswagen. Since they had to sign a Non-Disclosure Agreement, she recollects her experience in this interview leaving the confidential details aside.

All questions posed to the interviewees were kept similar in order to maintain consistency.

Future of Driving – Symposium at TU Delft

A symposium was held at TU Delft on the 25th of November 2016 where 6 keynote speakers from the vehicle and manufacturing industry spoke about the future of cars and the progress of automation in vehicles. A very short interview was conducted Serge Lambermont, Technical Director Automated Driving at Delphi to find out if designers have a scope in designing with sensor data.

RESULTS

Interview with Peter Vink

Type of data used by designers while improving the design of a car:

Professor Vink said that the type of data they used for design was dependent on the project and what they were focusing on. He stated an instance where the project was related to the user's health and they had sensors on the seat that had to measure the heart rate and respiration and also had data about pressure distribution. With this data, the seat would adapt itself based on the user's ideal pressure distribution. The data is used to sense the pressure and the motor adapts itself accordingly to change the seat positioning.

Aspects of cars that can be improved in terms of design, with data generated by cars:

Professor Vink said that temperature, pressure distribution and data on driving behaviour are a few aspects that can be used to improve the design for the car. For instance, temperature systems both heat and cool the car and since the human body is such that some parts need to be cooler than the others, the system could adjust itself based on the needs of the user.

On whether the data produced by the sensors on a car be useful in designing or improving a particular physical aspect of the car:

Vink stated that, at the moment, most of the data generated are used for designing or bettering traffic and infrastructure and nothing with respect to the interior of the car itself. But, recording how long people sit in the same position in a car is an important aspect that can be used to design the seat or make changes to it. So from his experience in this field, such data would be useful to redesign the interior.

He mentioned that currently, they are working on how they can make a complete car interior which senses temperature, pressure distribution, driving behaviour and comfort recording. This data can then be collected from many cars to see if an internet of things data can be formulated for that changes the interiors of a car.

Extent to which there is a difference in designing with data and user testing:

Professor Vink believes that both designing with data and designing with users is vital. For instance, when required to record emotions, it cannot be done without a user as the data cannot predict the outcome since it is very circumstantial. Reading responses of people while performing different experience based experiments cannot be replaced by data. Experiments conducted by Vink have shown that when people are made to sit on the car seat and allowed to play a game, their heart rate goes up. And then they are let to look at the scenery, it's calm and steady. Such results cannot be obtain with just data.

On a group level when comparing a lot of cars, data is useful, but it cannot be used when it concerns user needs as they're much more specific. But Vink believes that data gathering for design purposes is important as there will be more car sharing in the future. And that would lead to scenarios where the car can identify each user's needs. Hence it would be useful to have all the data stored.

On whether using data can hinder the designer's decision

Vink's answer to this was affirmative. He said that when designing with data, cars often do things that you don't want it to, and it becomes irritating. He gave an example of a design where the car detects if the driver has been seated for more than two hours and then flashes a red light. This was not well received by the people.

Interview with Reinder Happee

Type of data used by designers while improving the design of a car:

The interview with Reinder Happee, found that screening customer profiles, general vision on use and customer choice are the types of data used by designers in improving the design of a car. It was found that with customer profiling, the strategic design and marketing of the car can be changed.

Aspects of cars that can be improved in terms of design, with data generated by cars:

According to professor Happee, cars measure driver and other user postures. This data can be incrementally used now and also in the future to enhance the design to adapt it to how we sit in automated vehicles. This gives scope for the designers to change the aesthetics and seating positions of the car based on the data generated. It is possible that, in the future, every part that is fitted with sensors produces some kind of data that is useful for designers.

Other aspects

To a question if the data produced by sensors on the car can be useful in designing or improving a particular aspect of the car, Happee said that it was a nice idea that does not exist in the current industry scenario.

Happee also concurred that it would be a good idea to study the difference in designing with data versus designing based on user testing, although this is not being done currently.

He also mentioned that he does not know to what extent using data would influence or hinder a designer's decisions.

Interview with Alicia Calderon

Type of data generated by cars and their relevance to the user

According to Calderon, the main interest for the automotive industry regarding data generated by cars is that it keeps collecting different information from many different sources since it is a moving machine and computer. This can be processed internally and sent to third parties. Highly equipped cars are full of different sensors that constantly collect large amount of information. The interesting part is the administration and processing of that information, i.e. discovering the possibilities of what use that information will be to the driver of that car, other cars or infrastructure (such as traffic controllers, town halls etc.). Different ecosystems can be created involving a car, data transfer and third parties. Also, depending on the sensors and other information collecting technology that we equip the car with, different kinds of information can be obtained. So it is just a matter of analyzing what information helps you to create value in any way for the driver, the driving experience, the car company, traffic management, other cars, or any other party one can think off.

Aspects of cars that can be improved in terms of design, with data, generated by cars:

As per Calderon, data can be collected for almost any purpose. Depending on the technology we put in a car, we can measure anything, for example the wellbeing of the driver, if the driving experience is seamless etc. Such information about the driver's experience can be collected by the hardware and software fit in the car. These can be used to implement changes based on the data collected. For example on a car with a driver

interaction system based on screens, the system can learn the driver's choices and behaviours and adapt the software to it.

Her reflection based on her JMP experience is that; what makes new technologies based on connectivity and machine learning so interesting for cars is that cars can then learn both from their external and internal environment. This would make them better as machines for both their own drivers and other drivers. The idea of cars are we knew them 10 years ago has changed a lot; they were very rigid machines with limited functionalities, but the current scenario suggests that the future of cars will be as machines that will evolve with their environment and human behaviour.

DISCUSSION

From the interviews done so far, it is clear that there is a lot of scope for designers to design with data, at present and in the near future. An interesting insight gained through a short interview with Serge Lambermont during The Future of Driving symposium was that sensors indeed generate a lot of data that can be used by designers in order to change the design of some parts of the car. This is a promising point of view for designers, as in the near future, this is a definite possibility.

Professor Vink's interview validates this by giving certain examples of how data generated by sensors that detect heart rate, pressure distribution can be used to design seats that automatically adjust based on the data. It is interesting to note that Happee's statements are also on the same lines as Vink's. Calderon also stated a similar fact giving the example of measuring a driver's wellbeing.

From the interviews, it is clear that the future of the industry lies in efficient inter vehicular communication. With autonomous driving in the rise, data is even more important because it will change the way a car ride is viewed and experienced. This is because a fully autonomous vehicle world would involve car sharing. This means the vehicle needs to be smart enough to adapt to user needs and data is vital for this purpose. An example provided by Vink during his interview was that some people might want to, say, exercise in the car while some people might want to work and might need a more serious setting. So when there is car sharing, it is important for the car to adapt the interior based on the preferences of the user. For example, while going to work the user may want a work like setting in the car and while returning, something suitable for exercise.

With respect to the differences between designing with data and user testing, it is clear that both go hand in hand. Although both are equally important, at the moment, there is no study on how they influence each other or what the difference would be. Happee concurred that it would be a good idea to study the difference in designing with data versus designing based on user testing, although this is not being done currently.

As for data being a hindrance for designers while designing, it seems to be prevalent problem even today where the car system recognizes certain actions and responds in an undesirable way. For example, when the driver places a luggage on the seat next to theirs, the seatbelt warning sets off. This is not a pleasant experience. A similar scenario in the future, as explained by Vink could be as follows; the user seated on the front seat of an autonomous car may place luggage on the back seat but the car may sense that as a passenger and may the seat of the user at the front, in order to face the (nonexistent) passenger. Hence, there are pros and cons of designing with data produced by cars.

CONCLUSION

This paper explored the scope of designers in designing or improving cars using the data generated by them. From the interviews conducted so far, we can conclude the following:

1. Cars are evolving faster than ever now, and are continuously improving to fit the user's need. This means that the work of a designer in enhancing the user experience is growing. As cars get smarter, the designer needs to adapt to new methods of designing, as there is abundant data available for use.
2. The main areas where a designer at present can focus on to design based on data generation is the car's seat and user's posture. This can be used incrementally to adapt to how we sit in automated vehicles as that is the future of driving.
3. Sensors generate tremendous amount of data that is currently not being used to its full potential by designers. But the future of designing with such sensor data is positive as some sensors also collect data such as the wellbeing of the driver and this can be used to redesign or improve the overall comfort and experience of driving a car.
4. Although it would be interesting to study the difference in designing with data and designing based on user testing, it there is not much information available at the moment. But it is clear that data becomes more relevant in design when it is collected across several cars. Whereas, user testing caters to the specificities of the user. It would be interesting to picture a future of design where there is no user testing and all the improvements are incremental to the data collected.
5. Designing with data certainly has its own disadvantages and poses as a hindrance to designers at times.

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