



# Exploring Luxury In-Car Experiences Interim Report

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# Introduction

A luxury item has certain features that make it feel like a premium product. This might be influenced by the materials it is made of, its weight, and other factors. But what makes a piece of technology and particularly an in-car user interface luxury? Colours? Sounds? Animations? Perhaps how it smells? Manufacturers of such luxurious vehicles, as Mercedes-Benz S-Class [37] and BMW 7-Series [38], have created their own in-car scents to enhance the pleasure of driving. Bentley is also aiming to include scent-delivery devices into their future car models [39]. This project encourages the exploration of multisensory technologies. Specifically, the sense of smell, to make use of an automated scent-delivery device already available in the driving simulator lab. [1]

## Project Aims and Objectives

- **Luxury Perception**

This project aims to explore how luxury is perceived by the users and what factors contribute towards creating luxurious in-car experiences through researching what makes an experience luxurious and explore how users perceive luxury. The goal is to study other researcher's findings in the effect that certain factors, such as colours [13,32], shapes, dimensions or even scents [14,15], have on the perception of a luxury item or experience, and experiment with combining the sense of vision, hearing and smell [24,27] to design and create a luxury in-car experience.

- **Implement the Sense of Smell in Luxury In-Car Experiences**

Another aim of the project is to extend the contributing factors, traditionally, from the sense of vision and hearing to include the sense of smell for creating luxury experiences in the in-car context. The goal is to implement a scent delivery system to investigate how the sense of smell can contribute to creating luxurious in-car experiences. Based on Mr. Dmitrenko's past work [2,3,4,5] we can assume that this approach could be feasible, but one challenge that Mr. Dmitrenko has experienced is that his implementation of the scent delivery system was unreliable due to long delays between delivery and perception of the scent, and lengthy lingering times. His implementation was to deliver the scent through a tube straight in the air, in front of the driver of the car. An extension objective of this project is to experiment with a new prototype for the already existent scent delivery system [1] that could prove more efficient for the delivery of the scents, by delivering the scents in the AC vent, thus releasing it in a flow of air that is directed towards the driver. This method could prove more efficient than releasing the scent directly in the air in front of the driver because it would direct the path of the scent instead of it slowly expanding towards the driver, which could possibly lower the delays between delivery and perception of the scent. Another extension objective is to design and build a prototype of a car vent using a 3D printer instead of procuring one from a manufacturer.

- **Creating a Luxurious Graphical User Interface for the Scent Delivery System**

This project also aims to design and create two Graphical User Interface for the scent delivery system to study the effect that shapes and colours have on the perception of luxury in the in-car context. The need for a Graphical User Interface for the Scent Delivery System comes from the need to control certain aspects of the scent delivery system, such as what scents are currently installed in the system and their concentration levels, what scent is mapped to what notification, the strength of the scent for a certain notification, by varying dosages of essential oil released, as well as configuring other ways to use the scent delivery system, i.e. welcoming scent, delivery of a calming scent either on a timer or by a trigger, etc.

The goal is to create two versions of the graphical user interface with a similar layout, one using a simplistic and professional design, and another one with luxurious and exquisite design for the shapes, colours and sounds by using the information gathered from the research into the effects that these factors have on the perception of luxury.

The Graphical User Interface will be using concepts found in Perceptual User Interfaces [9] by including haptic feedback on the touchscreen. Research suggests that users were able to complete certain tasks significantly faster when using a haptic feedback enabled touchscreen when compared to traditional touchscreens [12].

- Conduct a User Study to investigate the effects of certain factors on the perception of luxury

The aim is to use the two GUIs in the case study to investigate the effects that colour, shapes and animations have on the perception of luxury by implementing the findings from the research done into colours and shapes in other industries, such as the retail industry [32], or brand management [30,31], and applying them into the in-car context. The primary objective of this study is to investigate the participants' perception of luxury experiences by asking them to use both versions of the graphical user interface and fill out a questionnaire after using each version and comparing the results with the findings from the research. We will also be collecting feedback about the idea of a scent delivery system in a car, their thoughts about the selection of scents and their mapping preferences of the scents, and also the opinion on using the sense of smell towards creating luxury in-car experiences. As an extension objective, if the new scent delivery system prototype proves feasible, the case study will include another part, to continue Mr. Dmitrenko's work [2], by validating the feasibility of delivering meaningful notifications about the state of the car or navigation, with notifications like "Fuel level low", "Wrong turn, recalculating route" or "Speed camera ahead". The study will investigate the time needed to notice the scent after the delivery and the amount of time the scent lingers after perception. This will be achieved by asking the participants to press a button when they notice the scent, and press another button when the scent is not noticeable anymore.

### Course Relevance

This project sets out to research and come up with solutions for integrating the sense of smell as a reliable and active part of driving, alongside the sense of hearing and vision, and use the sense of smell for receiving meaningful notifications from a car in the form of scents, as well as to explore and design ways to integrate the scent delivery system to create luxury in-car experiences. This relates to the degree I'm studying towards, Computing for Business and Management, because at the core, the project closely follows research done in Human-Computer Interaction, field which researches the design and use of computer technology, focusing on the ways in which humans interact with computers, and design technologies that allow humans to interact with computers in different ways. Also, in business, we work with products, and luxury experiences and premiumness can affect the success of a product, thus this project would contribute as a meaningful experience and skill on my resume.

The project will test skills that I have learned throughout the modules I studied during my time at university, such as my software engineering skills for the creation of a GUI as a platform for the scent delivery system to communicate with the car (in the context of the project, the driving simulation game), my professional writing and researching skills to design and create a luxury in-car experience which integrates the scent delivery system, as well as my project management and professional ethical skills to plan and conduct an ethical case study in a timely fashion and make efficient use of the resources provided to safely and efficiently finish this project.

## Professional and Ethical Considerations

As this project revolves around the user study, which will involve human participants in a controlled environment to investigate the effects that certain factors have on the perception of luxury in the in-car context, and using the scent delivery system to introduce the sense of smell as a contributing factor for creating luxury experiences, discussions about Professional and Ethical considerations started in the beginning phases of the project, and the planning and designing of the case study was done by closely following the British Computer Society Code of Conduct [40] and the University of Sussex' Research Ethics Guidance for projects.

During the first part of the case study, the participants will be asked to interact with each Graphical User Interfaces and complete a questionnaire about luxury perception of the GUI after using each version. In the second part of the study, the participants will be asked to drive the car using a high-end driving simulator, starting from the same point. During the driving part, the participants will be experiencing olfactory notifications delivered through the scent delivery system based on what is happening in the simulator, i.e. if the fuel tank is almost empty, the scent delivery system will deliver a certain scent which was mapped in the GUI to the notification "Fuel Level Low", and we will record the perception and lingering times to validate if the new prototype is feasible for this application.

The study will take place in a dedicated olfactory interaction space [1], where the participants will be exposed to different scents, delivered through the scent delivery system in the form of essential oils, specifically the "Miaroma" brand of scented pure essential oils from Holland & Barrett, scent list not decided upon at the time of this report. The scent delivery system works by running pressurised air from an oxygen tank, regulated to under 1.5 bars, into glass containers filled with pure or diluted scented essential oils, and through tubes that lead into the inside of the AC vent tubing, where it will enter the air flow and the scent will be directed to the participant. The vent will be placed in a location similar to the placement of an AC vent in a car in relation to the driver. All parts that come in contact with the essential oils will be coated with an oleophobic conformal coating to avoid contamination of the scents.

As the exposure to the essential oils will be very limited, the risks posed to the health and safety of our participants are low, but essential oils can cause allergic reactions [28, 29], so we will act with due regard to the health and safety of our participants by informing the participants of all the materials used for the study, and asking them if they are allergic to anything they are going to interact with during the experiment, and allow them to withdraw from the study if it poses a risk to their health and safety, or if they don't feel comfortable about any part of the experiment.

At the time of writing this report, the project is in the process of applying for an ethical approval, process which has been accounted for in the planning of the project, and we won't execute any part of the case study before the project has been approved by the University of Sussex' ethics committee. This project will be realised with the utmost regard for health and safety, and professional and ethical regulations, by making sure that:

- All of our participants are over the age of 18 and that they don't have a disability that may limit their understanding, communication or capacity to consent;
- They explicitly stated that they agree to take part in the study, and that their data could be used in the project;
- The participants will not be offered any incentives, and neither me nor my supervisor will be in a position of authority over any of the participants.
- The participants will have been informed in detail of all the details of the experiment at the beginning of the session, without intentionally leaving out any information about the evaluation

or materials used, that they can withdraw at any time and that they can ask any questions at any time, as well as debriefing them at the end of the session, and informing them of mine and my supervisor's contact details.

- All the collected data will be stored under a private password protected database, in anonymous form.

## Related Work

This project sets out to explore the factors that contribute to creating luxury experiences in cars by encouraging the use of multisensory technologies [27], specifically the sense of smell. This is achievable through the use of a scent delivery system, thus creating a new way for a car to send meaningful notifications about the car's condition or other external factors to the driver.

### Scent delivery research in other industries

Even though the idea of olfactory interaction in cars is still in its early stages [15], there has been extensive work done in engineering and developing scent delivery systems for multisensory theatres [22, 23], art [24, 25, 26, 27], Virtual Reality and Augmented Reality gaming and entertainment [18, 19, 20, 21], and wearable technologies [16, 17].

### Research in luxury perception

Luxury refers to high status, rarity, premium quality, prestige, and items that are perhaps superfluous or non-functional [11,30,31]. Only a few decades ago, luxury was an expression of excellence, which was exclusive and unique, and it mirrored by creative and tailor-made craftsmanship, made out of exquisite materials, but in recent years, this has transformed from being something accessed in the public place to being private, yet flavoured with conspicuousness [7].

When talking about creating luxury experiences, we have to think about an experiences-oriented approach, where these experiences are designed to be holistic, because specific aspects such as the brand context, store atmosphere or other human elements can influence customer experience, and the brand plays a big part in the perception of luxury. In order to be a luxury brand, it has to have "legitimacy in luxury" which means to have exceptional production process, a product of the highest quality, and a tradition or history associated with the brand [6]. Research suggests that enabling the consumer to see the product has a marked effect on consumer behaviour, thus by using certain techniques when designing and displaying products can have a critical role in influencing the success of those products [8].

When creating luxury experiences, we have to consider all factors that contribute to creating those experiences, such as what we see, smell and hear. There has been some research done in the coordination of vision and smell suggesting that the nose smells what the eye sees, this being demonstrated through a wine-tasting study, where oenology students provided odour descriptions of red and white wines, but without their knowledge, one of the white wines was coloured with odourless red dye, and the students described the "red" white wine using language typically reserved for red wine instead of typical language used for describing white wine, thus suggesting that the sense of smell is notoriously unreliable [10].

Other factors that have a big influence on the perception of luxury are colours and scents. Research in the influence of scent suggests that it has a positive influence towards service environments and enhance memory for certain brands [14]. Since colour can express a specific meaning, certain colours likely reflect a higher level of perceived luxury meaning than other colours do; religious rituals suggest that hues such as gold, purple, and silver represent luxury [33]. Other research done

in the retail industry suggests that here are two major approaches to choosing colours for a retail space. First there is a top-down approach, with colour temperature being a big influence, although this sometimes doesn't make a lot of sense for branding [34]. The second approach, bottom-up, focusing on empirical perspectives from different user studies on perception of luxury when it comes to colours [35]. Other studies suggest that past experiences play a determinative part in the perception of colour, thus making it hard to draw conclusions about what effect different colours have in the perception of luxury experiences [13].

#### Olfactory interaction research in cars

There has been some research done in introducing olfactory interaction in cars by Dmitrenko et al. [1, 2, 3, 4, 5] who have built their own scent delivery system and olfactory interaction space, where through multiple studies, they have been able to use the scent delivery system to send meaningful notifications to the driver, such as "Slow Down", "Refuel the vehicle", or "Passing by a point of interest", but the main challenges he encountered have to do with the perception and lingering of the scents. Through their many studies, they have concluded that with the setup he was using, the scent would be perceived by the user in no longer than 10 seconds and the lingering effect would last about another 9 seconds. This project aims to continue the research and figure out how to overcome the delayed perceiving of the scent and shorten the overall lingering effect with the objective of achieving a reliable way to implement scents as a mean to communicate different notifications to the driver.

## Requirements Analysis

This project sets out to research what factors contribute towards creating luxury in-car experiences, and design and create a multisensory luxurious experience that will be tested in a user study. The contributing factors towards the experience I'm creating are the sense of vision, hearing and smell, by creating a luxurious graphical user interface, with the knowledge collected from literature review, for the scent delivery system and comparing how this is perceived by the participants by creating another graphical user interface with the same functionality, but styling it in a simplistic, professional way, borrowing design aspects from other graphical user interfaces present in luxury production cars, such as Audi, Mercedes-Benz and BMW. This will be used in the user study to investigate if changing from the traditional styling design of car graphical user interfaces has an effect on the perception of luxury and if it plays a part in creating luxury in-car experiences. At the time of writing this report, I have not gathered enough information about how sounds contribute towards creating these luxury experiences in cars, but we will be incorporating the scent delivery system as a way to introduce scents that can convey meaningful notifications, or be used as a way to influence the mood of the driver.

#### Prototyping the graphical user interface

I have created a low-fidelity prototype for the graphical user interface (Figure 1) to showcase its functionality. The GUI will control certain aspects of the scent delivery system, by allowing users to change out the scents to whatever they desire and reconfigure what scents are in each slot. The olfactory notification settings will allow the users to configure what scents are mapped to what notifications and how strong those scents should be for each notification. Another implementation of the scent delivery system that could be perceived as luxurious is to implement it so it releases a familiar, relaxing and welcoming scent every time the user gets in the driver seat.

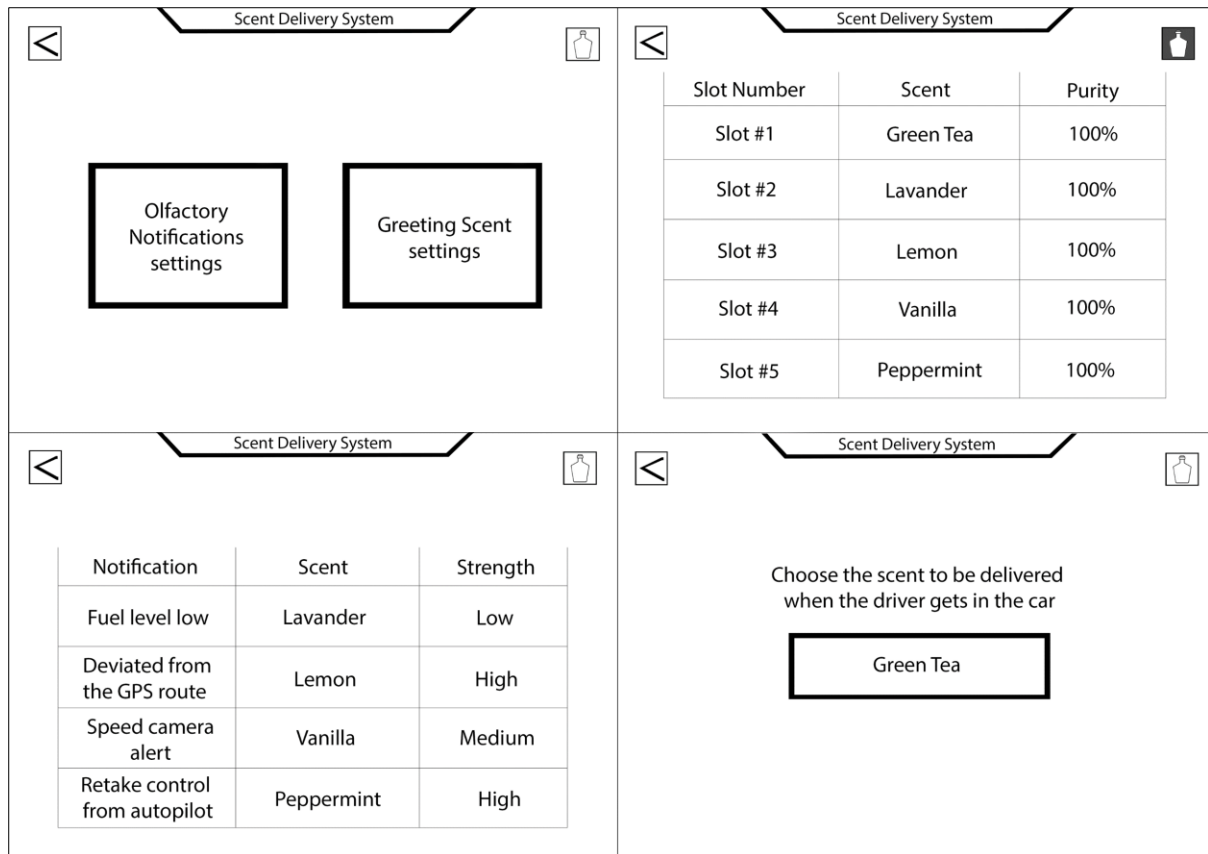


Figure 1: Low-fidelity prototype of the GUI

The new prototype for the scent delivery system

The new implementation tries to solve the perception delay issues by simulating a real-world application of this system, by delivering the scent directly at the end of the vent of the AC system of the car. This prototype will simulate a car with the operational AC on a low setting, by having a fan at the end of a tube, and a car vent at the other end with the fan providing a constant air flow through the vent. The scent delivery system will deliver the scent at the end of the tube, near the vent, and this will be mixed into the air flowing through the tube and be carried towards the user. In order to avoid scent contamination in the tube, the parts will be coated with an oleophobic non-scented conformal coating.

## Project Plan

At the time of writing this report the project is on time, with extensive research done about the perception of luxury, what are the factors that contribute towards creating multisensory luxury in car experiences, how colours, shapes and scents can affect the mood of a person and how they are perceived, and how to implement the sense of smell to design and create luxury in car experiences.

I have done some work towards designing the Graphical User Interfaces for the user study, and have created a low-fidelity prototype of the GUI to showcase the functionality of the scent delivery system. Also, I have done some work towards designing the new prototype for the scent delivery system with the continuous air-flow through the AC vent approach.

The project is currently in the process of applying for ethical approval by the University of Sussex' ethics committee. While I am waiting for the approval I will start gathering the resources needed for the user study, such as design and 3D print the vent grille for the scent delivery system prototype,

design and create the questionnaires and plan out the experiment, and finish designing and creating the GUIs.

There is really only one dependency in the project, and that is the fact that we have to wait for the ethical approval before we start doing the experiment, but outside of that, there are no expected delays in the project.

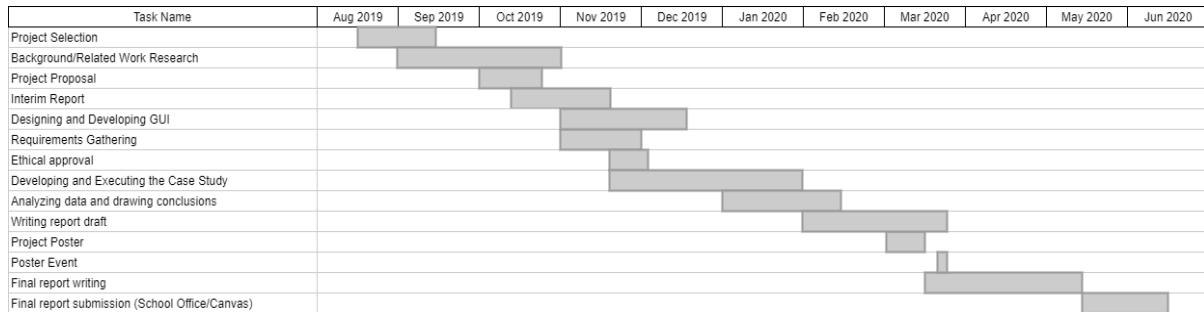


Figure 2: Gantt Chart of the Project Plan



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# Appendices

## Appendix 1: Project Proposal

### Exploring In-Car Luxury Experiences

A luxury item has certain features that make it feel like a premium product. This might be influenced by the materials it is made of, its weight, and other factors. But what makes a piece of technology and particularly an in-car user interface luxury? Colours? Sounds? Animations? Perhaps how it smells? Manufacturers of such luxury vehicles, as Mercedes-Benz S-Class and BMW 7-Series, have created their own in-car scents to enhance the pleasure of driving. Bentley is also aiming to include scent-delivery devices into their future car models. This project encourages the exploration of multisensory technologies. Specifically, the sense of smell, to make use of an automated scent-delivery device already available in the driving simulator lab.

#### Aims

- Explore how luxury is perceived by the users and what factors contribute towards creating luxurious in-car experiences.
- Implement a scent delivery system to investigate how the sense of smell can contribute to creating luxurious in-car experiences.
- Experimenting with a new prototype for the scent delivery system that could prove more efficient for the delivery of the scents. (Based on Mr. Dmitrenko's past work)
- Design and create two Graphical User Interface for the scent delivery system to study the effect that shapes and colours have on the perception of luxury in the in-car context.

#### Objectives

##### Primary objectives:

- Research what makes an experience luxurious and explore how users perceive luxury by studying other researcher's findings in the effect that certain factors, such as colours, shapes, dimensions or even scents, have on the perception of a luxury item or experience. Using the findings from the research, we will experiment with combining the sense of vision, hearing and smell to design and create a luxury in-car experience.
- Design the graphical user interface to control certain aspects of the scent delivery system, such as what scent is mapped to what notification, the strength of the scent (by varying dosages of essential oil released), as well as configuring other ways to use the scent delivery system (i.e. welcoming scent, delivery of a calming scent either on a timer or by a trigger, etc.).
- Create two versions of the graphical user interface with a similar layout, one using a simplistic and professional design, and another one with luxurious and exquisite design for the shapes, colours and sounds by using the information gathered from the research into the effects that these factors have on the perception of luxury.
- Conduct a user study to investigate the participants' perception of luxury experiences by asking them to use both versions of the graphical user interface and fill out a questionnaire after using each version. Using this data, we can compare the results with the findings from the research, and also collect feedback about the idea of a scent delivery system in a car, their thoughts about the selection of scents and their mapping preferences of the scents, and also the opinion on using the sense of smell towards creating luxury in-car experiences.

##### Extension Objectives:

- Prototype a new way of delivering the scents, based on Mr. Dmitrenko's past work, in order to combat certain problems that were rendering the olfactory notifications unreliable due to long delays between the delivery and perceiving of the scent and reduce the scent lingering duration. The new implementation tries to solve these issues by simulating a real world application of this system, by delivering the scent directly at the end of the vent of the AC system of the car. This prototype will simulate a car with the operational AC on a low setting,

by having a fan at the end of a tube, and a car vent at the other end with the fan on a low setting, providing a constant air flow through the vent. The scent delivery system will deliver the scent at the end of the tube, near the vent, and this will be mixed into the air flowing through the tube and be carried towards the user. In order to avoid scent contamination in the tube, the plastics will be coated with an oleophobic non-scented conformal coating.

- If the new scent delivery system prototype proves feasible, the user study will include another part, to continue Mr. Dmitrenko's work, by validating the feasibility of delivering meaningful notifications about the state of the car or navigation, with notifications like "Fuel level low", "Wrong turn, recalculating route" or "Speed camera ahead". The study will investigate the time needed to notice the scent after the delivery and the amount of time the scent lingers after perception. This will be achieved by asking the participants to press a button when they notice the scent, and press another button when the scent is not noticeable anymore.
- Design and build a prototype of a car vent using a 3D printer instead of procuring one from a manufacturer.

## **Relevance**

This project sets out to research and come up with solutions for integrating the sense of smell as a reliable and active part of driving, alongside the sense of hearing and vision, and use the sense of smell for receiving meaningful notifications from a car in the form of scents, as well as to explore and design ways to integrate the scent delivery system to create luxury in-car experiences. This relates to the degree I'm studying towards, Computing for Business and Management, because at the core, the project closely follows research done in Human-Computer Interaction, field which researches the design and use of computer technology, focusing on the ways in which humans interact with computers, and design technologies that allow humans to interact with computers in different ways. Also, in business, we work with products, and luxury experiences and premiumness can affect the success of a product, thus this project would contribute as a meaningful experience and skill on my resume.

The project will test skills that I have learned throughout the modules I studied during my time at university, such as:

- Software engineering skills for the creation of a GUI as a platform for the scent delivery system to communicate with the car (in the context of the project, the driving simulation game).
- Professional writing and researching skills to design and create a luxury in-car experience which integrates the scent delivery system.
- project management and professional ethical skills to plan and conduct an ethical case study in a timely fashion and make efficient use of the resources provided to safely and efficiently finish this project.

## **Resources Required**

- SCHI Lab – for access to the driving simulator, as well as for conducting the case study.
- 3D Printer – to create a prototype of a car AC vent.
- Essential oils and the pre-existing scent delivery system setup.
- A fan that could provide constant air flow through the vent, just like the AC in a car.
- An oleophobic conformal coating for the plastic parts of the system to prevent contamination of the scents.

## Appendix 2: Interim Log

### Meeting #1 (11.09.2019):

Preliminary meeting where we talked about the scope of the project and areas of exploration. Also talked about the planning of the project as a whole, specifically the case study.

### Meeting #2 (08.10.2019):

Discussed the ideas I came up with during the literature review, and started talking about the structure of the final report and deadlines (set a deadline for the “Related Work” section and a Project Proposal document). Also got to see the SCHI Lab and started planning the case study.

### Meeting #3 (23.10.2019):

Received feedback and advice on the “Related Work” section. Further discussed about the plans for the case study and discussed a schedule for access to the driver simulator.

### Meeting #4 (06.11.2019):

Received feedback and advice on the project proposal. Discussed about professional and ethical considerations of this project, as well as revised the plan for the project, based on the progress at that time.