Group #54
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Group Project: Self Driving Car Interface Design

Section 1: Summary

The team conducted research into three main areas affecting self driving cars. The first was how the driver interacts with the self-driving systems and the transfer of control to and from the car. The second area focused on what the driver and their passengers are able to do while the car is in fully autonomous mode. The third area was allowing the car to pick up people while there are no occupants in the vehicle. Each study integrated occupant safety and comfort with technology into the needfinding, design alternatives, and evaluations.In all three cases, the user types were heavily diverse. Car drivers are represented by most groups of people. The addition of self-driving actually increases the people who could potentially interact with this technology.In this analysis we are looking to increase our shared understanding of what the driver and passengers are able to do while driving and improve on existing prototypes. We will make refinements using new needfinding and prototyping rounds. The team is also interested in ensuring the driver is able to immediately regain control of the vehicle in case of an emergency or system failure.

Section 2: Needfinding Planning

Problem Space

The target domain for this project is a first generation self-driving car.
Currently driving absorbs a significant amount of time for people who commute via automobile. Self-driving car operators will find themselves with much more time to accomplish other tasks while driving. This means they will be able to interact with the car in different ways as well as expect new features from the vehicle to help them accomplish task previously unavailable to a focused driver.

User Types

This project will primarily focus on the workplace commuter; the commuter who spends at least an hour driving their car daily. Other user types are considered, but not primary focus:

1. People who work in a downtown office or who will be shopping at a mall where it is difficult find parking. It is more convenient if the car could park itself and pick up the owner later.

2. People who travel a lot will be out of town several days. They will let car drive back home after they arrive airport and drive to pick them up when they come back.

Plan 1: Naturalistic Observation

Naturalistic Observation will be a key needfinding method to gather data for the task we're studying. By taking on the role of a passenger in the vehicle, we will observe how drivers currently interact with automobile interfaces. These observations can take place over long distance road trips as well as shorter daily commutes, and will primarily consist of the targeted gathering of information about the user's interaction and evaluation of the driving interface. The key here is to observe specifics, and then abstract outwards and interpret them. Our focus will be on observing the user's interaction with the speed gauge, fuel gauge, and rudimentary autonomous functionality like cruise control.

During this observation process, we will answer specific characteristics of the data inventory:

- Who the user is?
- What is the age and relative expertise when it comes to driving a vehicle and using cruise control?
- What things in the outside world are competing for the user's attention?
- What are their tasks, and what are the subtasks that make those tasks up?

These questions are nicely answered by natural observation, because our attention will not be occupied by other stimuli. Despite our presence as a non-participating observers, we will still encounter certain biases, primarily confirmation bias and observer bias. To prevent confirmation bias, we will specifically look for signs that we wrong about any assumptions we made. A large sample size and target audience could help reduce confirmation bias. Observation bias will be limited by restricting interactions with the user.

Plan 2: Survey

Our final needfinding is a survey. We will recruit participants by sending out survey to OMSCS students and our colleagues/ friends. The questions we plan to ask are:

- Basic information like age, gender, whether driving cars and how long have been driving cars.
- Where they live and what kind of road/ weather condition they always drive
- How frequently they use cruise control
- What kind of interface they like- traditional or newer

- What they always do when driving
- Their concern about self-driving cars

The survey addresses who the users are, where the users are, and the users' needs, goals, and subtasks. The detailed questions, if properly framed, will provide the most significant information for the study. Surveys are very susceptible to observer bias. We will have other nonparticipants review the survey for leading questions to help reduce this bias. Surveys are also prone to voluntary response bias, resulting in potential oversampling of extremes. We will confirm conclusions with previous notes from other methods.

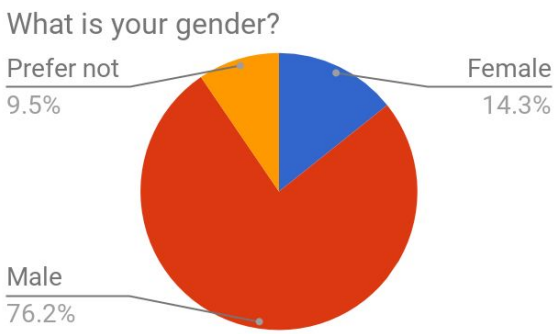
Section 3: Needfinding Execution

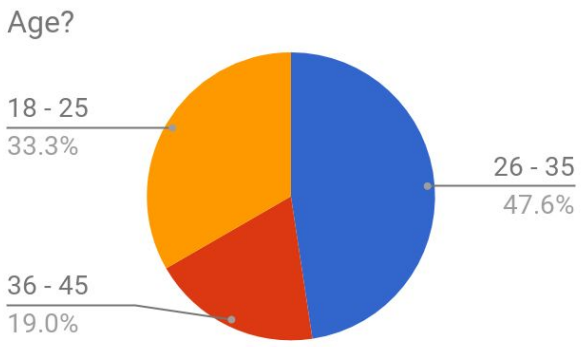
Needfinding Execution 1

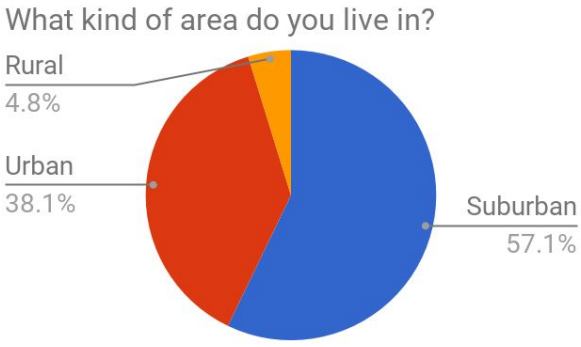
The first needfinding plan we executed was naturalistic observation. Riding as passengers, we observed nine individuals interacting and evaluating the automobile interfaces of several vehicles (Appendix). In general, Gulfs of Evaluation and Execution were both relatively narrow, likely due to user expertise and years driving. However, there was slight but notable hesitation when using simple autonomous functionality, like Cruise Control. This hesitation was more noticeable in lower end vehicles equipped with less robust information displays, where the user was not given clear output upon engaging autonomous functionality.Natural Observation very successful. In order to escape the Confirmation bias, we carefully examined the interactions, looking for any conflicts to our assumptions. We also made sure to include several vehicle models and a relatively robust sample for this short time frame.

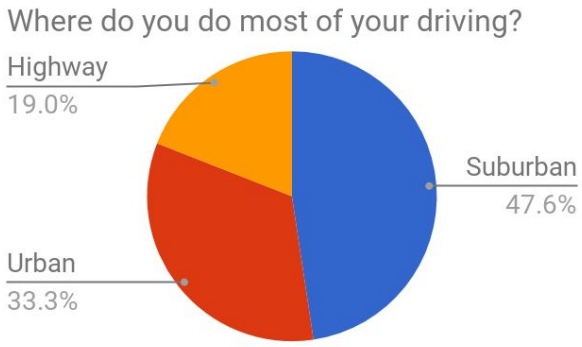
Needfinding Execution 2

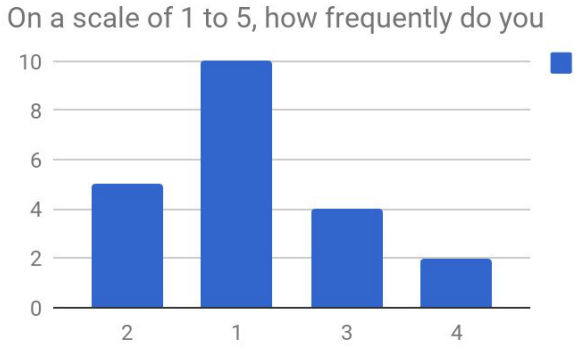
Raw Results:

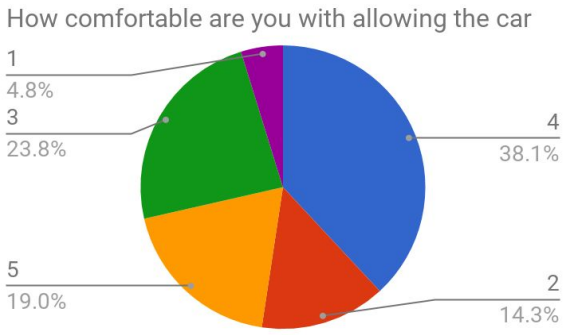


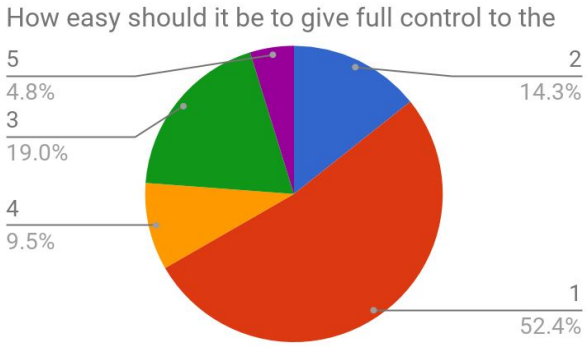


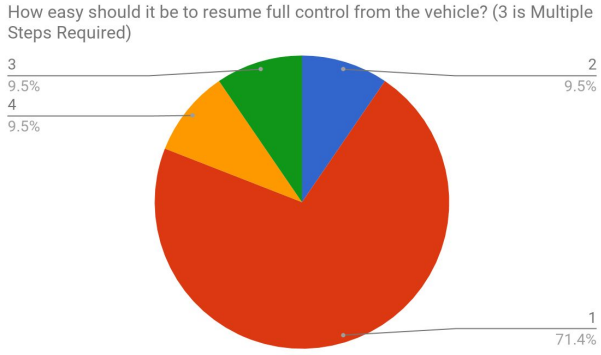












The survey illustrates that current drivers are hesitant to have a car completely

assume control and wish override to be seamless. We had two non-participants review and make suggestions to survey questions. We specifically asked them to look for questions which may lead them to answer something over something else.

Data Inventory:

Who are the users?

The samples proved this to be a broad group, where anyone living in the US above the age of 16 is a suitable user. They can read, execute, and evaluate the results in the context of the interface.

Where are the users?

The context of the task limits users to the driver seat of a vehicle. Both needfinding exercises illustrated drivers could be anywhere in the world, in rural and city locations.

What is the context of the task?

It's clear from the participant observation exercises that driving, while a cognitively taxing task, is constantly being interrupted by other passengers, various road-side distractions, the phone, the navigation system, and the driver's' own thoughts.

What are their goals? What are their needs?

More than half of survey participants were interested in leisure activities while in a car (reading books, watching movies, etc.). The survey also illustrated that more than half require it to be very easy to switch to and from self-driving mode.

What is the task and subtasks?

The task being evaluated here is the handoff from the user to the system in order to engage autonomous driving. This was primarily supported through the use of Needfinding plan. Subtasks involve manipulating traditional affordances to control the self-driving system.

Defining Requirements:

Since the focus of our interface will be on those who have properly learned how to drive and are experienced behind the wheel, the requirements of our interface will be largely focused on maintaining current interface standards and design, while integrating new self driving features. This is an iterative improvement to a previous cycle of prototype development and evaluation.

Section 4: Design Alternatives

Brainstorming Plan:

Each member will conduct individual brainstorming prior to meeting for a group session and will have different criteria for their individual sessions. One member will brainstorm for about 2 hours. They will look for three distinct interface ideas, executed through different mediums, text, voice, and physical objects. A second member will spend 30 minutes brainstorming with the intent of identifying 20 different ideas. The third member will conduct three 10 minute sessions with breaks in between. They will look for 10 ideas in each of the following areas: getting to destination, working while commuting, and relaxing while commuting. Once the team conducts their individual sessions, they will meet to combine idea. The team will look to identify at least ten ideas helping users transition to and from self-drive mode.

Brainstorming Execution:

The raw results of the team brainstorming are listed below:

1. Purely visual interface (disengage through navigation system)
2. Auditory interface:
    a. Vocal cues? Could be finicky..
    b. Maybe auditory feedback on transition (beep, or tone)
3. Traditional buttons that incite handoff:
    a. Dedicated button on steering wheel?
    b. Dedicated button on center console?
4. Confirmation of transition to and from modes:
    a. Visual popup in Driver information center?
    b. Auditory tone on transition?
    c. Tactile vibration?
    d. Combination of all three mediums?
5. Contextual switching and prompts?
    a. Based on road conditions (inclement weather, road markings are poor.)
    b. Based on gps information (maybe certain roads aren't ideal for self-drive)
    c. Relative to road type, freeway, etc
6. Tolerance and error messages are important
    a. How to ascertain or inform the driver that road conditions aren't optimal?
7. Car can operate without operator in the vehicle.
    a. Self-drive through app.
    b. Curbside pickup.

8. Voice Commands:
    a. “Enter / Terminate Self-Drive”
9. Emergency Action:
    a. Vehicle stops if driver doesn’t resume control.
    b. Increasing tone / visual cues to gain attention.
10. Passengers can interact with self-drive:
    a. Each seat has access to controls.

Summary of brainstorming: The individual and group sessions were very successful in guiding the team to 10 usable ideas. The next step is to develop selection criteria and choose two ideas to model as prototypes.

Selection Criteria:
The requirements that are a priority for this task, focus on the conformity to current vehicle interfaces design standards in order to maintain simplicity, modern affordances, and mapping to the common information contexts. As such, the prototypes we go forward with have to maintain this, while remaining largely affordable. The needfinding surveys and exercises outline the desire for simplicity and ease of transfer. For these reasons, we will select design ideas that do not require significant alteration to current car interfaces.

With these requirements in mind, we chose the purely visual interface, and the visual \ auditory interfaces to compare. Both will be similar in design, the latter just offers the addition of auditory cues.

Section 5: Prototyping

Prototyping Background:

The requirements that are a priority for this task focus on the conformity to current vehicle interfaces design standards in order to maintain simplicity, modern affordances, and mapping to the common information contexts. As such, the prototypes we go forward with have to maintain this, while remaining largely affordable. For example, we can’t actually alter vehicle software because that would be difficult, time consuming, and dangerous to the driver, so a functional prototype isn’t an optimal choice. Instead, we’re going to focus primarily on ideas that can be conveyed through visual and auditory interfaces, through wireframe prototypes.

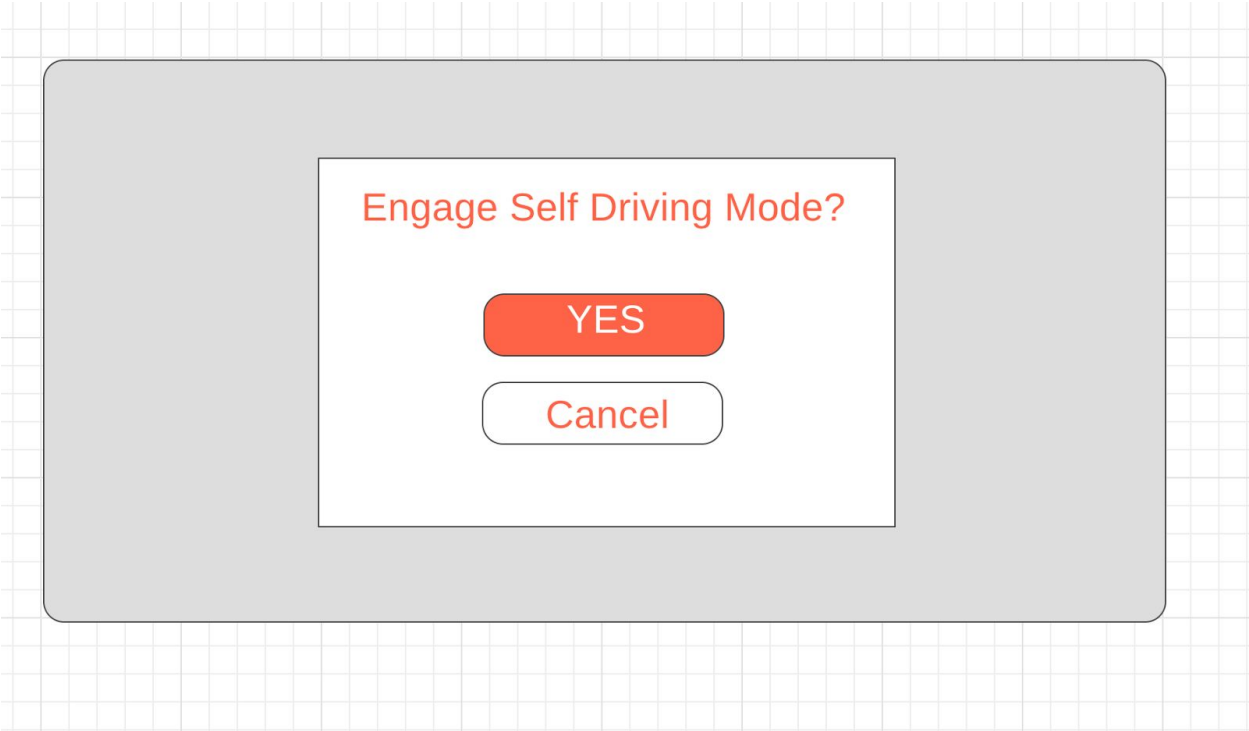
The wireframe prototype allows us to get more actionable feedback from users, while providing an even more clear flow of screens and storyboard compared to the other two prototypes. However, we do lose some fidelity when it comes to the auditory tones and feedback that is presented, as well as the tactile feedback and interface that is contextually presented by the verbal interface in accordance with the car.

From our initial needfinding in the individual M assignments, it was clear that users prefered wireframe prototypes because of their increased fidelity compared to Wizard of Oz alternatives. With an increased understanding of what users prefer when it comes to evaluation of the interface and its output, we've focused our next iteration of prototypes down into two categories, auditory feedback and purely visual feedback. These prototypes focus on the output that is delivered to the user in the event of a transition of driving control from the user to the autonomous and vice versa. In our previous prototyping rounds, this particular vertical was where user behavior was the most differentiated, and in order to design the optimal interface for the task, we thought it prudent to tackle this specific aspect in our group prototypes.

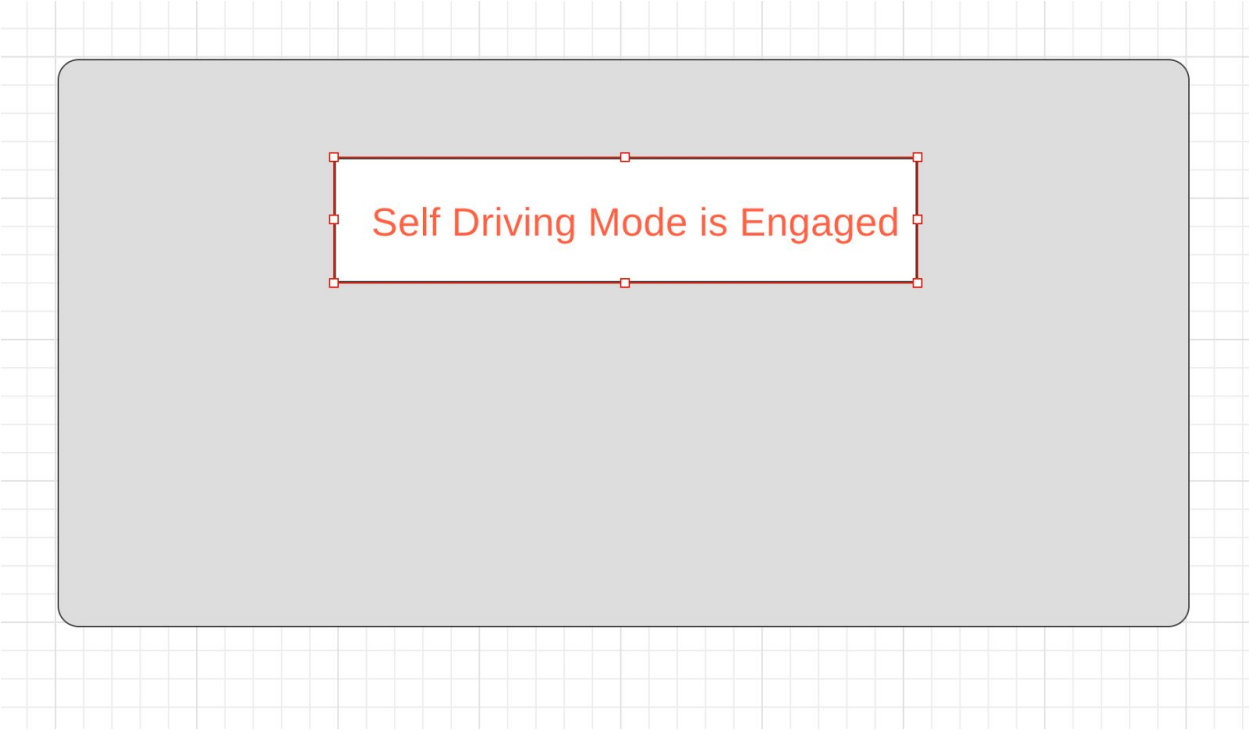
Prototype 1:

The following screens comprise the wireframes of the first prototype, which focuses on purely visual feedback during the handoff between driver and vehicle. These wireframes are understood to represent the information screen that is nestled between the speedometer and other gauges on the driver's dashboard. As such, you can imagine that it is fairly small and requires ample usage and coverage of the limited screen real estate, while remaining uncluttered and simple.

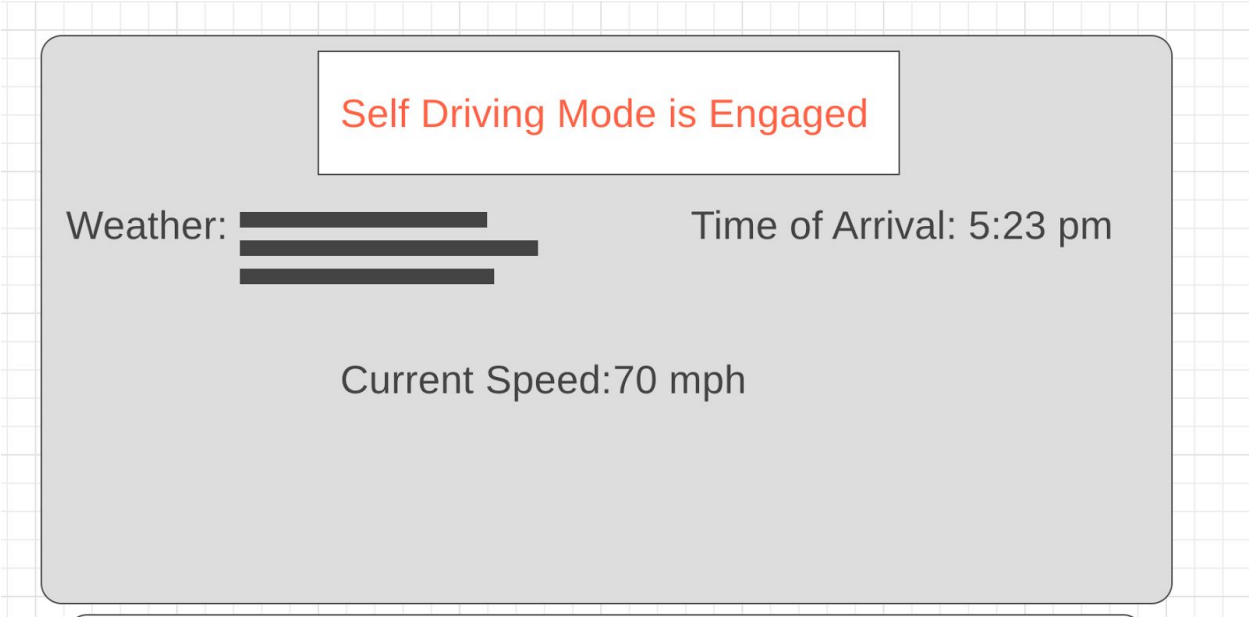
Contextually, when the user presses a button similar to modern cruise control, they are instead prompted with a screen asking them whether they would like to engage fully autonomous mode. The user can now navigate using the arrow buttons that are present on the steering wheel to select yes or no, or alternatively, they can click the cruise control button again to engage or simply wait five seconds to cancel. The purpose of a secondary check, rather than to simply initiate onclick, is to allow the user to verify their decision in case of an accidental engagement.



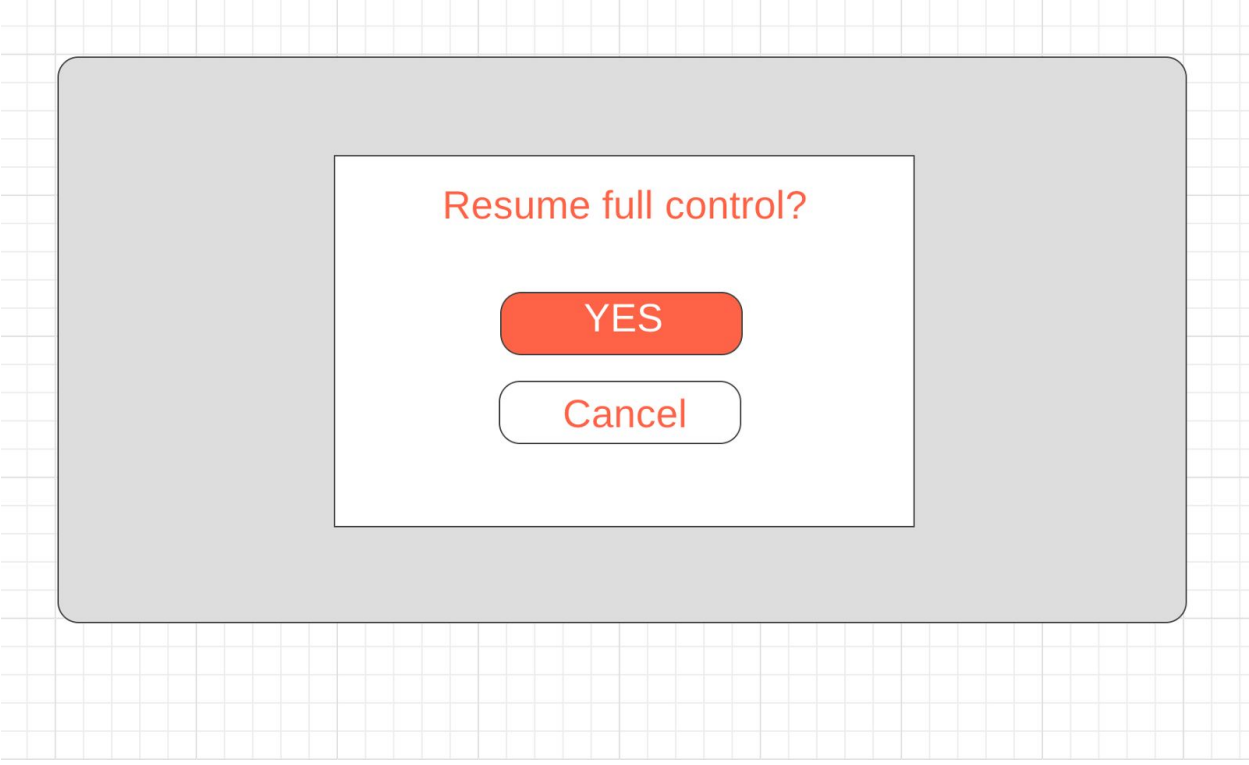
In the visual only prototype, the screen is the sole conveyor of whether or not autonomous mode has been successfully engaged, with a short message indicating engagement popping up:



After this, the screen defaults to relevant information while in the autonomous state, including weather conditions, speed, and estimated time to a destination if any is entered.



While engaged, if the user wishes to disengage self driving mode, they simply have to click the same button they used to engage, and a very similar flow presents itself!



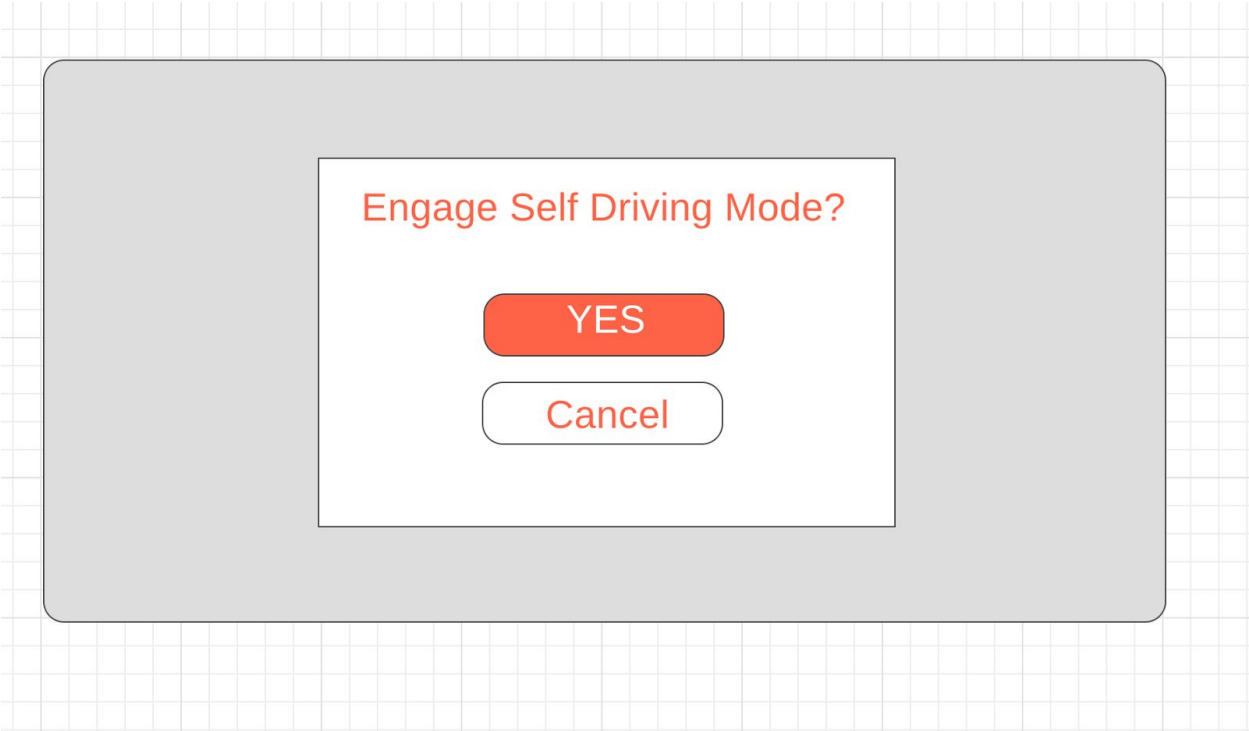
The driver can again navigate using the arrow keys on the steering wheel, or they can use the click or wait method outlined in the engagement module above. Again, here we see that the secondary check is present, simply there to properly ensure that the driver does indeed want to resume control, and did not do so accidentally. This is particularly important at this stage, especially because of the danger that could result if the driver unwittingly disengages self driving mode. We want to make sure our system is fairly rigid, and forces the driver to behave in a certain way, in order to preserve their safety while on the road.

This follows the standard flow for current cruise control technologies and interfaces in modern cars, allowing us to follow the same requirements we put forth, while maintaining relevant affordances and mappings to the right informations. This prototype also meshes very well with the audience described in the data inventory, as it relies on their use of modern vehicles and doesn't propose any radically differing design implementations compared to what our targeted users are used to.

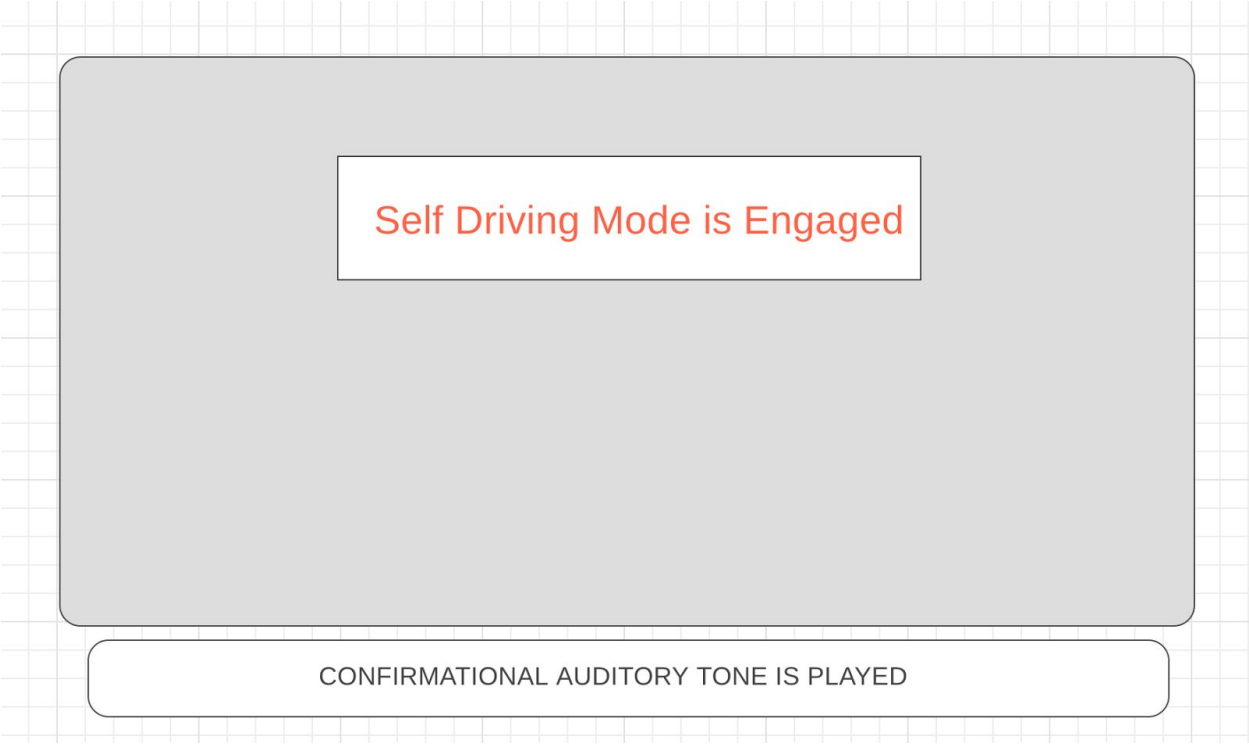
Prototype 2:

Because of our extensive work in the M assignments, our prototypes for the group project can be fairly focused, because we're narrowing in on optimal interfaces according to users. As such, our second prototype is very similar to our first, with one important differentiating factor: the use of auditory output to convey successful transition of control between the user and the vehicle, in both directions. As such, the flow of the wireframes is very similar for engagement and disengagement.

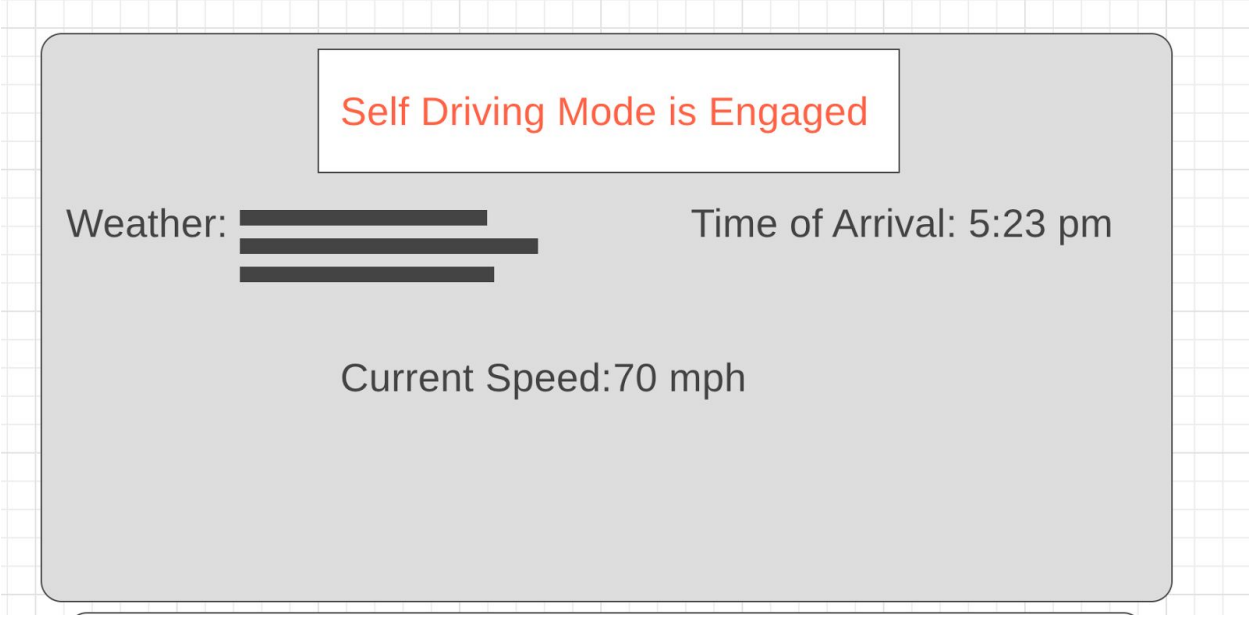
For a user to engage the autonomous functionality, they follow the same process as the first Prototype:



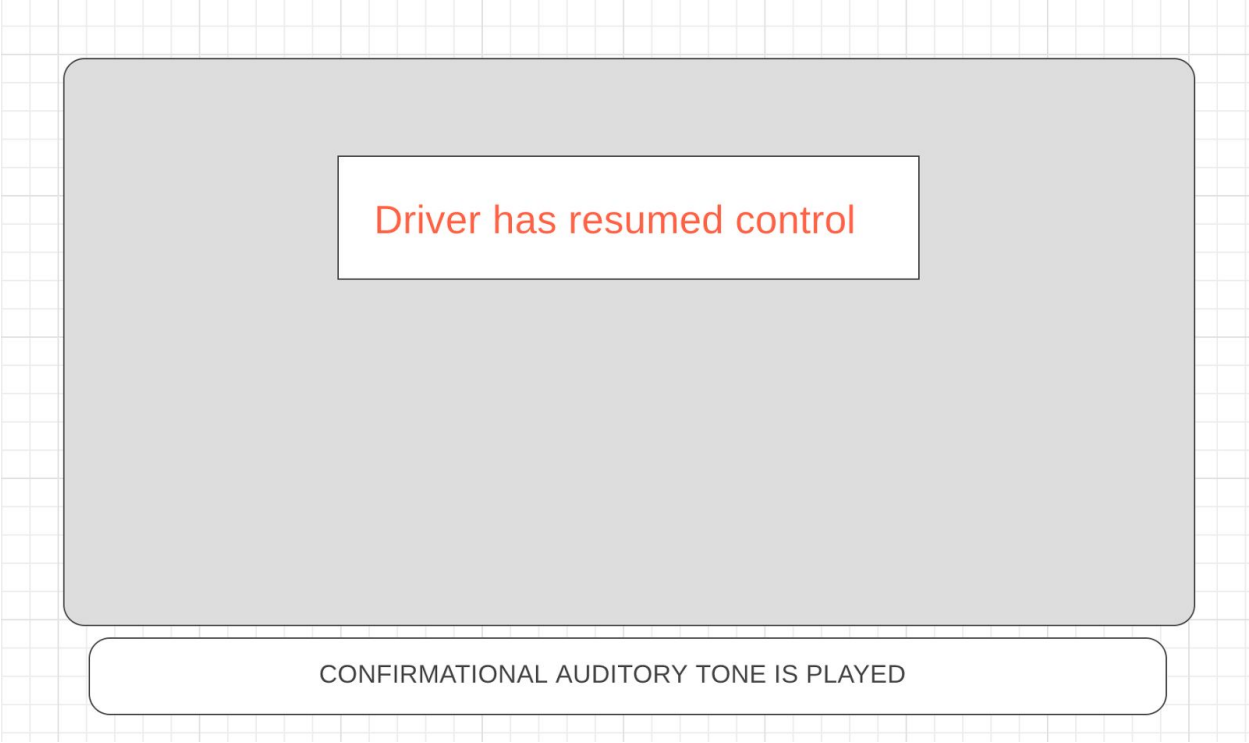
Upon clicking through the secondary screen and engaging the system, the user will now be presented with both the visual screen from before, along with a positive confirmatory tone, similar to the tone hosted at https://www.youtube.com/watch?v=NovyGK3L9hY.



Following this, we resume the default mode



Upon taking back control, the user will see the a similar screen to the the last prototype, but again, there will be auditory confirmation that the user can listen for indicating that they are in control.



While the two prototypes provide similar flows, there is a significant difference here, and that is that the second one allows the user to keep their attention on other stimuli while exchanging control with the car, rather than having to focus on the screen. In being able to hear the output and evaluate it for success, they can maintain vigilance on road conditions, which is incredibly important in maintaining safety on the road.

Section 6: Evaluation Planning

Qualitative Evaluation

We would conduct a survey for wireframe prototyping for both purely visual feedback and auditory feedback. The reason is that although these are medium to high fidelity prototyping, a survey can be properly answered independently of the evaluation of the prototype itself, allowing for the delivery of both to be asynchronous. Surveys also provide another tangible benefit, notably the fact that the data can be processed largely through software, allowing for greater analysis and pattern recognition using computation.

We will largely be recruiting from family and friends, as has been suggested in class for this exercise, but we do have a stringent requirement of the individual participating being a licensed driver. Since the evaluation is a survey, it will be done at their earliest convenience, anytime over the course of a week. As long as they have a stable internet connection, they will be able to access the survey, which will be hosted through Google Surveys. This software platform automatically records responses and provides various useful analytical tools as well.

In the survey we will present the wireframing screen for both purely visual feedback and auditory feedback respectively and give a brief description, then ask questions as follows:

- *Some basic information like age, gender, whether driving cars and how long have been driving cars*
- *Whether using cruise control often?*
- *What did you like about the* purely visual feedback *interface?*
- *What did you dislike about the* purely visual feedback *interface?*
- *What did you like about the* auditory feedback *interface?*
- *What did you dislike about the* auditory feedback *interface?*
- *Show 1 or 2 screens (for both prototypes) and ask some questions to test whether users can understand the meaning of our interface correctly.*

- *Show 1 or 2 screens (for both prototypes) and ask some questions to test whether users can tell what they should do to accomplish their goal.*
- *Show 1 or 2 screens (for both prototypes) and ask some questions to test whether users understand what effect would be if they do some actions.*
- *Did you feel the interface (for both prototypes) was easy to use? Please rank it from 1 to 5, with 1 being the easiest, and 5 being the most difficult.*
- *Were you able to easily evaluate the output of the interface (for both prototypes)?*
- *As a whole, does these two interface make autonomous vehicles seem like a real possibility for your commute/use? Please select from range 1 to 5.*
- *Depend on the description of these two kind of interfaces, which one do you think is better?*

This evaluation would help us address users' understanding and satisfaction of the interface. Through it we would get to know whether the interface met some principle like discoverability, affordance or mapping. Also we would know the user's' basic information like who the users are and where are they living. Besides this evaluation can let us know which part of the interface did not work well and whether our prototype meets user's goal and need.

Predictive Evaluation

We would use cognitive walkthroughs to do evaluation for wireframe prototyping for both purely visual feedback and auditory feedback. Despite the weaknesses of cognitive walkthroughs, i.e the fact that we are evaluating our own designs introduces clear and polarizing biases, the nature of the task requires that we use them as part of our predictive evaluation. The handoff between a user and a self driving system is largely unknown to the majority of drivers on the roads today, and as such, they will be largely naive to the interface and may need to explore it quite a bit to become comfortable operating it. Because of this, walking through the interface and carefully evaluating each screen and node in the frame of both the gulf of evaluation and the gulf of execution is necessary.

The user's goal would be to shift control of the car's driving to an automatic system that would allow them to divert their attention to other stimulus, i.e talking to family or checking emails. The goal that will be evaluated in this assignment will only be that specific handoff, and no other task. Walking through the screens of the wireframing prototype will allow us to map out every action succinctly, and check for both gulfs and design heuristics throughout.

Section 7: Evaluation Execution

Predictive Evaluation:
The predictive evaluation, while in many cases not the most useful, is incredibly vital when dealing with an experimental interface for a new technology like autonomous driving. To follow the logic and cognition of the interface adequately, we deemed a cognitive walkthrough the best course of action. In order to so properly, we evaluated not just what a user will do, but also how they'll know what do in the contexts of the Gulfs of Evaluation and Execution, as well as design principles like simplicity, affordances, and mapping. The walkthrough is done using the second wireframe prototype included, utilizing both auditory and visual outputs.

Walkthrough:

- While driving, the user will periodically consult their driver navigation screen, as is normal behavior.
- This is mostly done in order to check various road and environmental data.
- The user's goal is now to divert their attention from the road in order to accomplish other tasks, and they reach to engage the self driving mode through physical switch on the steering wheel.
- A popup appears, indicating to me as a user that the system understands what we want to do, and maps it out into two options: engage or cancel.
- We click engage by pressing the switch again, which was indicated to us through the affordances earlier.
- There is a popup with the output "Self Driving Mode Engaged"
- A high pitched tone is also played.
- We take these two outputs to mean that the system is successfully driving.
- We can confirm this by checking to see the speedometer, and whether it is independent modulating, as well as noting the presence of the "Self Driving Mode is Engaged" badge on top of the screen.
- This evaluation of the speedometer needs work, since it had to be prompted by the user, rather than provided by the interface.

The Cognitive walkthrough, while summarized above, proved to be very useful, as it made clear where there needed to be further narrowing of the Gulfs of Execution and Evaluation, as well as better uses of affordances. The two most prominent areas, ripe for improvement, were the fact that the user had to click again to confirm, which can be improved through more clear mapping and easier to read output, as well as the information presented during the the self driving state.

Qualitative Evaluation:

We choose to use the survey as our qualitative evaluation and got 22 responses. As it is a survey, all questions to different participants run the same for all sessions but I gathered the information for their gender, age, and some other background. This time most of the responses are from our classmates from OMSCS and next time I may send the survey to more people with different background to get more reliable feedback. The detail of survey is in appendix. Based on the feedback, some takeaways I can get is:

- Most participants are male- which may bring some bias in the view of gender related. Other factors like age and hours spent on driving have a pretty even distribution. More than 95% participants live in either urban or suburban.
- Most participant can understand both the visual and auditory interface well and can figure out how to use them to start and stop self-driving mode. Which means our interfaces met the design principle of discoverability and simplicity.
- 95% of the participants answered the questions of 'what would happen if you do/ hear something' correctly. Which means that our interfaces met principles of affordance and mapping.
- Some participants have concerns that they don't understand our weather information. In our next iteration we will improve it.
- Some participants point out that the sound for entering and exiting self-driving mode should be different, which can give a better feedback. We will also consider and improve it in our next iteration.
- More than 80% participants like our second prototyping with auditory.
- Most participants think our interface is easy to understand and use. Which met the ease & comfort principles.
- More than 60% participant believe our interface can help improve the possibility using self-driving car.

From this qualitative evaluation, we can know users prefer the interface with auditory. This interface works good but still need some improvement. We would reconsider the design in the view of a better tutorial of how to understand the information center such as weather. Also we would improve the feedback for the tone when entering and exiting self-driving mode by using different voice. That would help to shorten the gulf of evaluation.

Section 8: Conclusion

This iteration of the design lifecycle was meant to improve an already established interface design. Specifically we were looking to identify how best to engage and disengage self-drive mode and what forms of feedback would be needed. We also wanted to ensure the modes couldn't be triggered accidentally. Although the design was a small and iterative change, we still moved through each phase of the design life cycle.

We started with a current model driver information center (the screen in the middle of the traditional gauges on the dash). The research began with a needfinding survey with twenty respondents and naturalistic observation. The results of needfinding illustrated that users and drivers geographically dispersed and are of all ages, above 16, male and female. This meant we needed an interface change that would be easy for new users to understand while not restricting expert users; the car must be able to be fully controlled by the driver at any time. The most significant result of both the survey and naturalistic observation is that drivers are not ready to be in a car with complete autonomy.

The team then brainstormed ideas to improve the current systems. The intent was to look for ideas that would integrate into an existing model of steering wheel, pedals, and dashboard. Using the results of needfinding, we landed on two prototypes with only a minor distinction. Both models involved a single purpose self-drive button on the steering wheel. One prototype would only confirm transitions via the driver information center and the other would display the notification and play a tone through the car.

Next the team built two wireframe prototypes of the driver information center. One showed the visual prompts and the other showed the same prompts, but added the note of an auditory cue being played. We found a tone online that evaluators could listen to by pressing on a link. We did not create any wireframe for the button, because the focus was on the evaluation of pressing the button. We want to be sure drivers are aware they are changing modes intentionally.

After building the two models, the team needed a way to compare them. We decided to perform a survey to gain qualitative feedback and a cognitive walkthrough to gain predictive feedback. The goal of the survey was to compare preferences for the use of an auditory confirmation versus a purely visual one. With the walk through, we were looking to see if the steps of initiating and terminating self-drive mode were clearly mapped and that no other forms of feedback or interaction seemed necessary.

The results of the cognitive walkthrough showed us that the mapping needs improvement. There is nothing, other than the visual cue, telling the driver they need to press the button a second time to initiate self-drive mode or terminate it. The interface requires confirmation for safety, but it could be confusing when you intentionally press the button and nothing actually happens. Another cue or potentially a longer press of the button could help this.

One potential concern with our survey was that the majority of participants were male, which could present some gender bias. However, more than 95% of the participants correctly identified how to initiate and terminate self-drive mode. Most of the participants found the interface easy to use and that the interface is likely to make self-driving more possible. While the majority (80%) prefered the auditory cue with the visual, many noted the tone we played was unacceptable and would need to be changed.

We determined from this round of the design lifecycle that users are comfortable with using the driver information center along with a self-drive button. Our team would now like to know what additional things the users would like control of in self-drive mode or if they would like hybrid mode of autonomy. We would probe how to manage those interactions, while keeping with affordances traditionally found in cars today. From the results of the survey and the cognitive walkthrough we would want to look at making improvements to the interface with auditory feedback and scrap the purely visual one. The next step in designing the prototype would be to build wireframes and mock-ups of vehicle controls. Ideally we could use the dashboard of a modern car and replace the driver information center with our own and add the mock-up of our controls (i.e a turn stalk and a touch screen). The wireframes would allow us to evaluate if the added information keeps the simplicity of the interface. While the mock-ups would allow us to evaluate if traditional affordances are as valuable as many drivers currently think. We would evaluate the mock-ups using a semi-functional, but stationary, system. We would ask groups of people to enter self-drive mode and get out of self-drive mode. One model would have people using a touch screen to do this the other model would have people using traditional interfaces. This would give us quantitative feedback on which interface method is actually quicker.

For the mock-ups we would likely do another round of surveys to gain more qualitative feedback on display types and notification preferences. In the survey we would compare design layouts for information pertaining to the self-drive mode. We want to know if it’s preferred to nest information or have it all displayed at once.

Each round of the design lifecycle would be focused on small and iterative changes to the interface. With the first generation of self-driving cars, it's important to ease people into comfort with the technology. Changing too many things will likely be off-putting to the majority of potential consumers. This has been a phenomenal learning experience for our team! Learning about user needs in the context of a cutting edge technology like autonomous navigation has been incredibly enlightening, and we hope to see novel, safe interfaces in the future.

Appendix 1: Raw result of needfinding survey

What is your age? 21 responses

16 - 18 0
18 - 25 7
26 - 35 10
36 - 45 4
46 - 55 0
56 - 65 0
65+ 0

What is your gender? 21 responses

Female 3
Male 16
Prefer not to say 2

How many hours do you drive a week? 21 responses

< 5 4
5 - 10 15
10 - 20 1
20 - 30 1
30+ 0

What kind of area do you live in? 21 responses

Urban 8
Suburban 12
Rural 1

Where do you do most of your driving? 21 responses

Urban 7
Suburban 10
Highway 4
Small roads 0

What are your usual weather conditions? 21 responses

Clear	18
Foggy	0
Rainy	1
Snowy	0
Windy	0
Night	1
Maryland	1

On a scale of 1 to 5, how frequently do you use cruise control while driving? (3 is Frequently) 21 responses

1	10
2	5
3	4
4	2
5	0

What would you rather do with the time you spend driving? 21 responses

Work	1
Leisure(Books or Shows/Movies)	11
Gaming	3
Talking to or calling others	3
Sleeping	2
Sleeping, Biking, Computering	1

Would you prefer traditional affordances or new ones? 21 responses

Traditional (buttons, levers, switches, sticks, paddles, etc)	3
Newer (touch screens, gestures, voice)	11
Combination of both	7

How comfortable are you with allowing the car full control of driving? (3 is indifferent) 21 responses

Value	Count
1	1
2	3
3	5
4	8
5	4

How easy should it be to give full control to the vehicle? (3 is Multiple Steps Required)21 responses

Value	Count
1	11
2	3
3	4
4	2
5	1

How easy should it be to resume full control from the vehicle? (3 is Multiple Steps Required)21 responses

Value	Count
1	15
2	2
3	2
4	2
5	0

What are your primary concerns regarding self driving vehicles?

	Not Concerned	Little Concern	Some Concern	Concerned	Most Concerned
Safety	3	3	1	5	10
Cost	4	5	5	7	1

Privacy	3	6	3	5	4
Moral Dilemmas	7	8	3	3	0

What other concerns do you have? 11 responses

Traffic rules
Increase in traffic
Continuing to allow drivers to select their own speed. The one hesitation I have about self-driving is that I will no longer be able to go faster than the speed limit.
Impatient people reassuming control from the car and causing problems.
I have read about multiple problems with self driving cars such as giving my car the ability to "chose the safest option." For example, A.I. in a specific situation sees a mother and child step out into the road. The car also knows that I am the only person in the car. Should the car chose to hit the mother and child or chose to swerve and potentially injure me, the one who purchased the car. Personally, if I am the owner of a self driving car, I would want it to protect me at all costs assuming the resulting accident would not be the car's fault.
na
Lack of hive mentality. Self driving cars would probably work better with everyone doing the same but those who don't threaten the system
none
You being such a sexy bastard

Appendix 2 : Raw result of evaluation survey

What is your age? 22 responses

16 - 18	0
18 - 25	6
26 - 35	8
36 - 45	6
46 - 55	2
56 - 65	0
65+	0

What is your gender? 22 responses

Female	3
Male	17
Prefer not to say	2

How many hours do you drive a week? 22 responses

< 5	9
5 - 10	8
10 - 20	5
20 - 30	0
30+	0

What kind of area do you live in? 22 responses

Urban	8
Suburban	13
Rural	1

Where do you do most of your driving? 22 responses

Urban	6
Suburban	7
Highway	8
Small roads	1

What are your usual weather conditions? 22 responses

Clear	16
Foggy	0
Rainy	1
Snowy	2
Windy	1
Night	1
all of the above	1

Prototype 1 (Visual Only)

Do you understand what the interface is trying to convey? 22 responses

Yes	18
No	2
Maybe	2

Do you know how you would accomplish the task of starting and stopping self-drive mode? 22 responses

Yes	17
No	2
Maybe	3

On a scale of 1 to 5 how easy is this interface to use? 22 responses

Value	Count
1	6
2	7
3	6
4	2
5	1

What would happen if you pressed the self-drive button? 22 responses

Enter self-driven mode
The driver can leave the car drive by itself.
Engage Self Driving mode prompt is displayed.
switches driving modes
It will ask for confirmation to engage self-driving mode.
i prompted to engage auto drive
either self drive is engaged or disengaged
You will be prompted to answer whether you want to enter self-driving mode
The car would enter self driving mode
Car gives a confirmation dialog.
Car would drive itself.
Prompt to confirm self-driving mode
The autonomous driving system would totally take over
.
Toggles self-drive vs auto-drive
it would drive itself.
self-drive engaging
It will switch to autonomous mode
prompt to check if you want to engage self-drivingm mode
start or stop autodriving, depending on the state
user prompted with question asking if they want to engage in self-drive mode
Self driving mode is enganged

What do you like about this interface? 22 responses

Value	Count

.	1
Clear popups asking you to engage or disengage self driving mode.	1
Good structure, feedback, constraints	1
I like that it's simple. I click a button and there are two options. I click the same button again and there are two options.	1
It asks use to confirm before proceeding.	1
It's clean and clear	1
It's simple and straightforward	1
Its simple and direct	1
Large clear, controls	1
NA	1
Simplicity	2
Simplicity.	1
Simplicity. Takes minimal steps to engage self-driving/resume full control mode.	1
clear	1
it is simple	1
it's very simple and to the point	1
null	1
seems simple to use with just a little experience	1
simplicity	1
straightforward	1
super simple	1

What do you not like about this interface? 22 responses

NA

I do not like screen touch to switch controls. I think a physical real button for switching is better.

Weather information shows bars which is confusing and not informative.

There isn't enough info on the prototype to be able to tell

I could not find anything that I did not like.

needs little more information on the process to take back control e.g. does it happen suddenly or is control given back gradually

If someone hadn't used the interface they may not know how to disengage

It depends on the ease of access to change from self-driving to full-control. You want to be able to have visual on the road at all times

how the fuck do you exit self driving mode

The second screen seems unnecessary.

I'm confused about the "weather" display. That's why I said I don't understand what the interface is trying to convey. Otherwise, it's quite simple and intuitive.

Not obvious at first that the steering wheel button exists, and how that navigation would work.
"Engage" is kind of a hard word, it almost sounds like I'm about to launch some missiles or something. I would prefer something more normal like "Start"
.
I can't figure out what the weather indicator means
null
I would preferred symbol
Maybe some more data points can be show when in autonomous mode. However, I don't believe it is needed. I like the minimalism
needs more work. How is the user confident that the car is ready to self-drive. secondly how does car transfer the control to user when user is not attentive.
I'm not sure where the selfdriving button is. Is it outside this interface? I would probably also need some routing status of the trip.
I'd like to see the autonomous mode screen fleshed out further. I think displaying additional information would be nice. Maybe a navigation screen.
Clicking same button to take full control. How do you discover it that the same button operates full driving mode

Prototype 2 (Auditory)

Do you understand what the interface is trying to convey? 22 responses

Yes	18
No	1
Maybe	3

Do you know how you would accomplish the task of starting and stopping self-drive mode? 22 responses

Yes	19
No	1
Maybe	2

On a scale of 1 to 5 how easy is this interface to use? 22 responses

Value	Count
1	5
2	6
3	5
4	5
5	1

What does it mean when you hear the tone? 22 responses

Successfully enter or come out of the self-driving mode
I touched a button.
Your selection has been confirmed.
That I want to get the hell out of the car because the tone is annoying
Either self-driving mode is engaged or disengaged.
the system state has changed
the self drive is either engaged or disengaged
You have switched modes, whether it is self-driving to full control or the other way around
Which tone?
It means self driving is engaged.
Self-driving is engaged.
Self-driving mode is engaged
Self driving mode has started
.
That self-driving mode is toggling on or off
you have taken over control of the car.
engaing, disengaing
You have changed modes
which tone
It means I've successfully start/stop self driving mode.
you've entered or exited self-drive mode
self driving mode

What do you like about this interface? 22 responses

good feedback
I have immediate feedback that I have touched a button.
Auditory feedback is nice to have.
The visual part
Again, simplicity and feedback.
simple
I like the auditory feedback
It notifies you that you have switched, leaving no confusion
The buttons are large and clear
The tone reminder
Simplicity
Simple
It's simple
.
Gives additional feedback
null
distinct

Again very simple and clear
NA
simple.
I like that it adds confirmation that a user has entered self-drive mode with an auditory sound.
multiple ways for same feeback

What do you not like about this interface? 22 responses

na
I cannot distinguish start from stop.
Once again the weather information is confusing. Also what to press on the car to reach these screens isn't explained.
the annoying tone
Similar sound for engaging and disengaging self-driving mode
the tone to engage is the same as the tone to disengage
I do not like that it is the same tone
Nothing different than the first response
How do you exit self driving mode?
In this case the confirmation screen is not needed
Same as previous interface.
Again, not obvious where the "self-driving" button is. Assuming it's on the steering wheel.
I might want to be able to toggle the sound if it gets annoying. At the very least I would want to be able to adjust the volume of the sound
.
The tone is a supplement, but not strictly necessary.
null
might miss the sound
The dinging sound might get annoying for me personally. I think using a subtler tone would be good
slightly better than previous because of the alert
Adding the voice tells me better the results of pressing the button, but I still have to look at the screen to click the "yes" or "cancel".
I think entering and exiting should have two different sounds.
same button performs multiple operations. Not sure I need the current weather, I can see outside. What would be nice is weather from an hour from now.

Comparison

Which Prototype do you prefer 22 responses

Prototype 1 (Visual Only)	3
Prototype 2 (Visual w/ Audio)	18
No preference	1

On a scale of 1 to 5 how does this interface improve the possibility of you using a self-driving car? 22 responses

Value	Count
1	4
2	3
3	8
4	6
5	1

What improvements (if any) would you make to either interface? 13 responses

Physical button other than screen button for switching. Think about a situation that in the noon and driver wears sunglasses. That is hard to see a screen clearly. And use different sound to indicate start and stop.

Improve the weather information.

A nicer tone

more information on how control is taken and given back in the background.

change the tone for engaged vs disengaged. two different buttons or a display showing how to disengage for new users

Clear button to exit self driving mode

Explain what "weather" means/does.

I would like to see the screen for how to put in an address

Both are great!

I prefer the visual only. I think that version was nice and simple. No improvements needed

Enable more voice controls, add route status

add to the autonomous mode screen and use two different sounds for entering/exiting self-drive mode

better handling while switching from auto to taking full control