

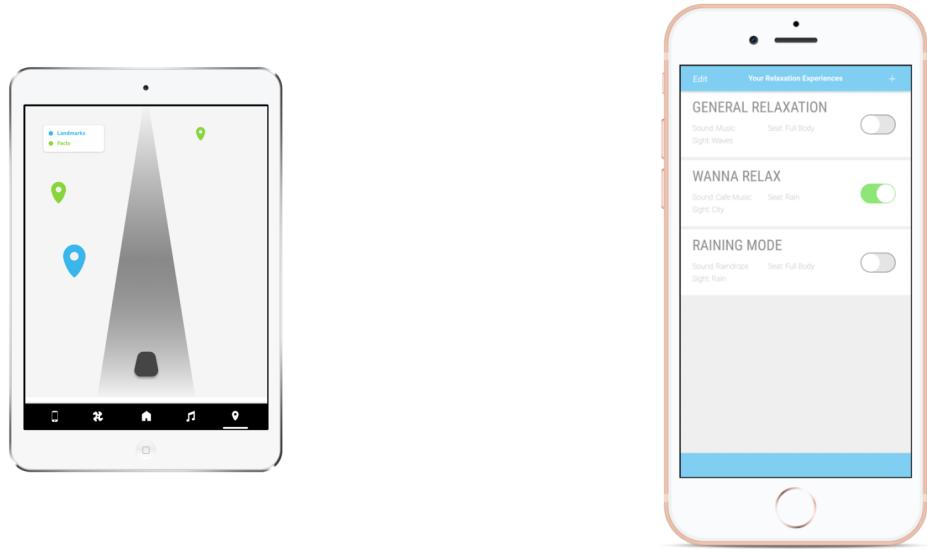
# Autonomous Vehicle Futures at BRAVO

*UX Design & Research Internship, Summer 2018*

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During the summer of 2018, Alice Agogino and Euiyoung Kim officially launched the [Berkeley Research for Autonomous Vehicle Opportunities \(BRAVO\) Group](#) — a collective focused on developing novel user experiences for self-driving cars. Through a sponsorship from Renault, our founding undergraduate team was tasked to **reimagine autonomous vehicle scenarios**, with our final deliverable to be **simulations of these scenarios** in an airstream provided for us by the Renault team. As one of two designers on the team, I spearheaded needfinding, ideation, prototyping, usability testing, and visual presentation assets. Throughout the summer, we collaborated extensively with our software and hardware teams in order to create two AV simulations that we would present to our sponsors in early September.



# The Challenge

Before beginning, we talked to our stakeholders about their expectations and interests. They made clear two particular interests:

1. Immersive, multi-sensory experiences
2. Understanding what makes the mobility experience unique, as opposed to taking a stabilized experience into the AV (i.e. a home setup).

From there our team sought to solve the following problem statements:

1. *How might we allow passengers to effectively utilize multiple humans senses on the road within an AV?*
2. *How might we enhance the mobility experience in an AV?*

These target questions provided for us the opportunity to **split our work into two potential scenarios**: one tackling the former, and the second tackling the latter. This gave us room to provide perspective on two key interests, without spreading ourselves too thin trying to fit both into one scenario.

# Research

The first couple weeks of preliminary research was lead by the design team, in order to gain an understanding of the current AV space as they related to our scenario

challenges. My goal for this preliminary stage of research was to **stay broad, without delving too deep into the two specific different design challenges we had.**

We focused our research around 3 main points:

1. **Current work on AVs by competitors and researchers:** What problems have been explored in this space, and how can we provide something new?
2. **Passenger and pedestrian needs and pain points on the road:** Who are we designing for, and what are their user needs?
3. **Simulation tools and resources that Renault and BRAVO could provide:** What can we make given the resources we have?

After defining these main areas of investigation, I defined the research plan and divided the work to begin our secondary research. The research process goes as follows:

1. **Past M.Eng. Research:** Given that the past M.Eng. team had done 6 months of user research in the AV space, we decided to leverage this information for our own project.
2. **Secondary research:** We did research on projects that other automotive companies were working on to define areas that were less explored.
3. **Communication with stakeholders:** We visited the Renault-Nissan-Mitsubishi office in Sunnyvale to talk to our industry mentors and managers, in order to highlight expectation and advice, goals as a brand, and tools they could provide for our final deliverable.

## Key Insights

After two weeks of literature reviews and synthesizing past research findings, we were able to move forward with several key insights that we would take into our ideation:

1. **There is a visible pattern of unrest when it comes to AVs, as it relates to users' levels of autonomy.** A big user need was the ability to control how they communicate with the vehicle, as well as other road users in order to prevent accident. This makes sense given the news of accidents related to AV mishap.
2. **A comfortable, satisfying interior enhances the passenger experience.** The moment a passenger steps into a vehicle, they immediately notice sensory pleasures and seek to find where it derives from in the vehicle.

3. **Passengers crave customizability.** The availability of features was a key way for users to access the ability to customize their experience, especially as it related to comfort.
4. Adding to the above point, features also enable **interaction with the environment**, also enhancing the passenger experience.

## Persona

Working with our key insights and pain points, we established a main persona for each of our two HMW questions — Stressed Sam, and Curious Cameron. With these personas, we established our target users' key needs and pain points, in attempts to draw out a storyline for further ideation.



**Stressed Sam**

Given Sam is a full-time student and part-time cafeteria employee who lives far from campus, he should be able to more effectively use his travel time as a way to destress before and after a long day of hard work.

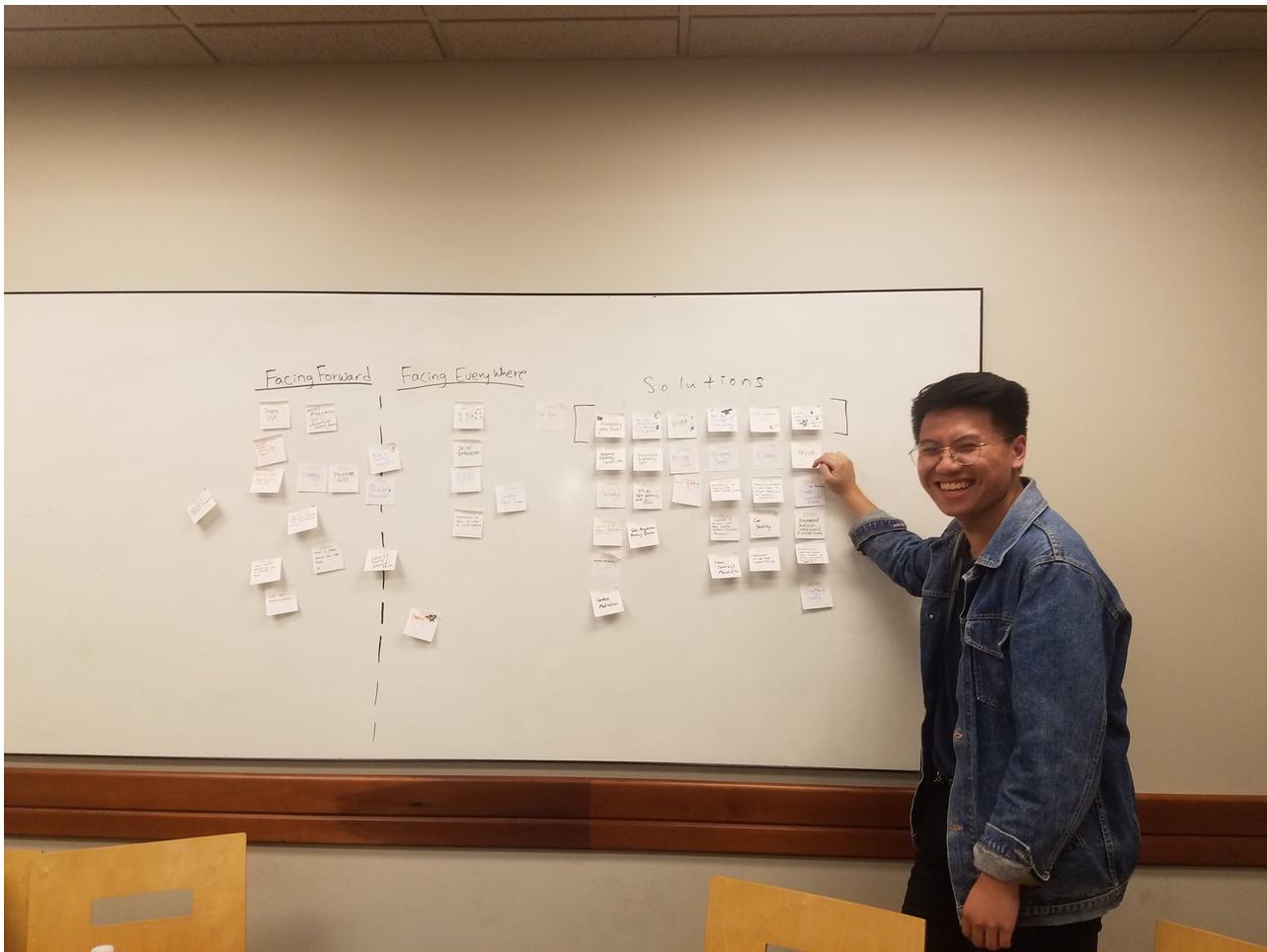


**Curious Cameron**

Given Cameron is traveling through Yosemite for the first time, she should be able to gain a better understanding of her surroundings as to enjoy her travels as much as possible.

## Ideation

From defining this persona, the design team led a brainstorming session for the whole undergraduate team, moving forward with mapping out pain points Stressed Sam and Curious Cameron would have, and creating potential solutions from those defined points.



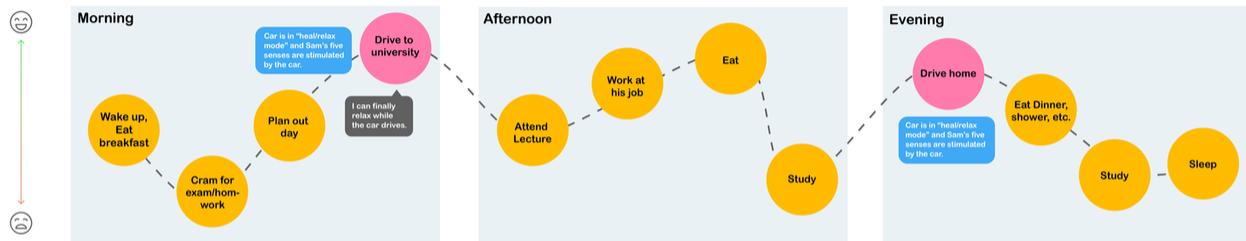
*Post-its, featuring me.*

We continued to converge until we ultimately decided on our two solutions:

1. For Stressed Sam, to use a **immersive experience to alleviate stress through multi-sensory relaxation** that a user could freely customize.
2. For Curious Cameron, to have **touch screen surfaces with pop-ups about the environment that one can interact with** (i.e. landmarks, facts, restaurants, etc.)

To support ideating to a final user experience, I created **to-be journey maps**, as to better visualize **touchpoints, potential interfaces, and user flows**.

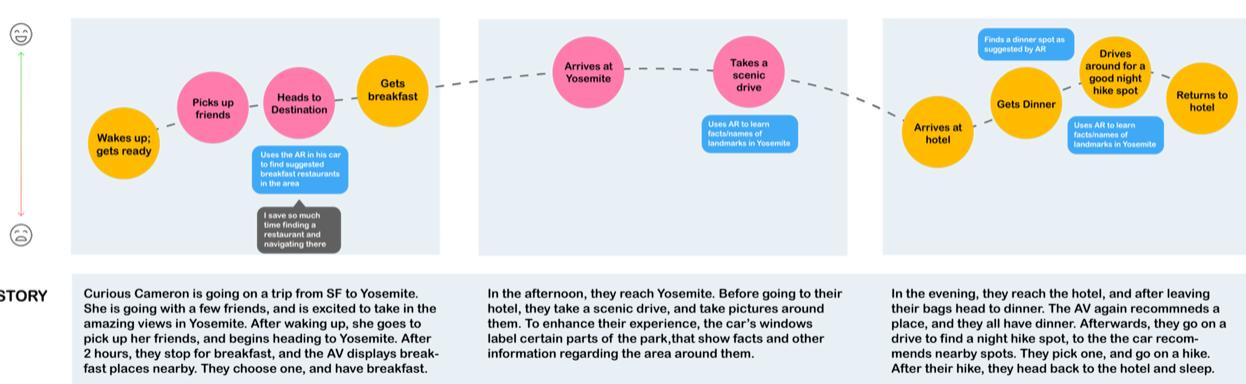
## Stressed Sam's Journey



STORY	In the morning, Stressed Sam hectically works on various tasks in order to cram for his exam. He's obviously very stressed from all this, so he enjoys the time to mentally and physically relax while he's in the car, using the vehicles "heal/relax mode."	In the afternoon, he continues to follow a jam-packed schedule, from going to classes to working a part-time job, to lastly studying for work due the next day. After all this, he's clearly very tired.	In the evening, he knows that once he gets home, he will have to study once again. The drive home provides a nice break for him before he has to work again. Once, again, he turns on heal/relax mode. After a long night of studying, he does to sleep stressed, but at least he can relax again once he's in the car on the way to campus.
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OPPORTUNITIES	1) Vision: Entire surface of the car streams a video that destresses Sam. 2) Hearing: Sound effects reduce Sam's mental stress. 3) Smell: Aroma therapy mode is on.	4) Taste: Car has nutritional food stored for Sam. 5) Touch: Sam's body is taken care by the massage mode.
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## Curious Cameron's Journey



STORY	Curious Cameron is going on a trip from SF to Yosemite. She is going with a few friends, and is excited to take in the amazing views in Yosemite. After waking up, she goes to pick up her friends, and begins heading to Yosemite. After 2 hours, they stop for breakfast, and the AV displays breakfast places nearby. They choose one, and have breakfast.	In the afternoon, they reach Yosemite. Before going to their hotel, they take a scenic drive, and take pictures around them. To enhance their experience, the car's windows label certain parts of the park, that show facts and other information regarding the area around them.	In the evening, they reach the hotel, and after leaving their bags head to dinner. The AV again recommends a place, and they all have dinner. Afterwards, they go on a drive to find a night hike spot, to the car recommends nearby spots. They pick one, and go on a hike. After their hike, they head back to the hotel and sleep.
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OPPORTUNITIES	1) Vision: Augmented reality to enhance visual landscape through facts, effects, etc. 2) Hearing: Enhancing sounds of surroundings that are blocked out by car itself. 3) Touch: Chair movement and haptics as it relates to the surroundings sounds and sights.
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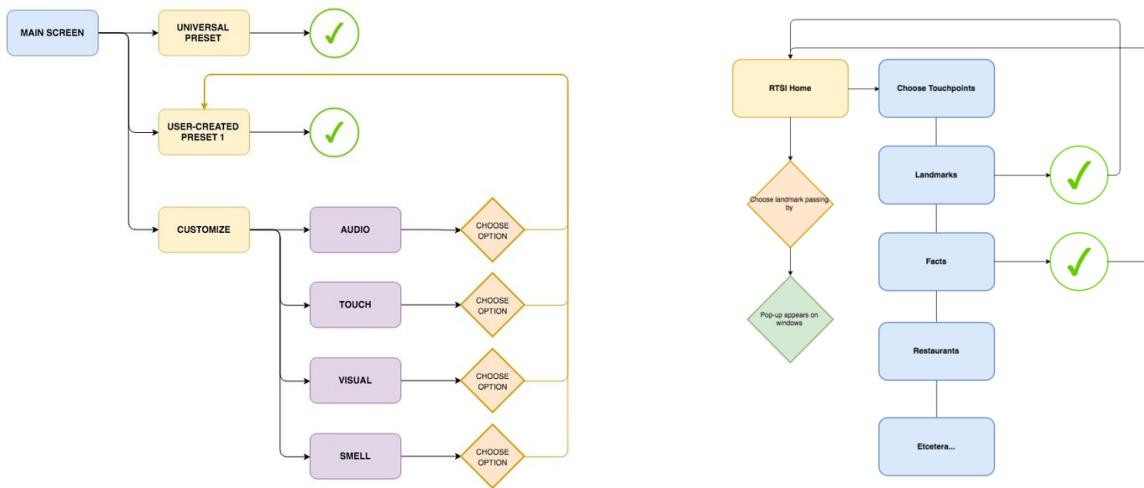
# Our Solutions

From the ideation phase, the design team proposed final concepts for our two scenarios:

1. For Stressed Sam, a mobile application, in which users would create a "relaxation preset", which would include four different settings: **visuals**, projected on the vehicle's surfaces; **audio**, played on the speakers; **haptics**; controlled through a massage chair; and **smell**, sprayed throughout the vehicle (which after

some user testing decided to get rid of, because the smells became slightly nauseating 😟). Internally we began calling this the **SS Interface**.

2. For Curious Cameron, a **dashboard feature** we called RTSI (Real-time Surround Information), that would **visually emulate chosen environment touchpoints to interact with**. As a user would click on a touchpoint, **information about it would pop up in real time on the vehicle's windows** (for example, clicking on a landmark touchpoint on the dashboard would create a pop-up stating the name of the landmark and a historical fact with it.). Like for the SS Interface, we called this one the **CC Interface**.



*Initial user flow of Stressed Sam scenario.*

*Initial user flow of Curious Cameron scenario.*

# Prototyping

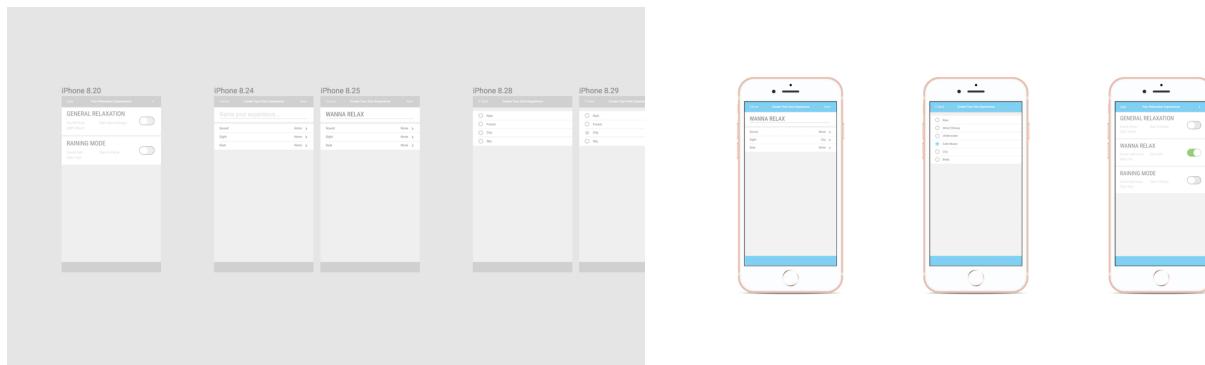
As the sole member with digital design experience, I designed the mobile interfaces for both scenarios. Below, I outline my thinking and process while designing for each scenario:

## Stressed Sam

I wanted to center the SS Interface's design around the idea of a "preset", in which the interface would be easily formatted to entice new preset creation. I did so by implementing familiar design elements from commonly used apps frameworks that

do just that — such as the alarm clock app, or the note-taking app. In this way, **the design was intended to build a sense of autonomy and trust, by highlighting customizability and feelings of familiarity, respectively.**

After conducting some basic internal user testing, I fixed the interface slightly to account for minor changes, and designed a mid-fi version that I would pass on to the software team to develop for further usability testing. You can try out this prototype [here](#).



*A couple of low-fi iterations, which we would use to conduct basic, internal user testing.*

*SS Interface mid-fi's.*

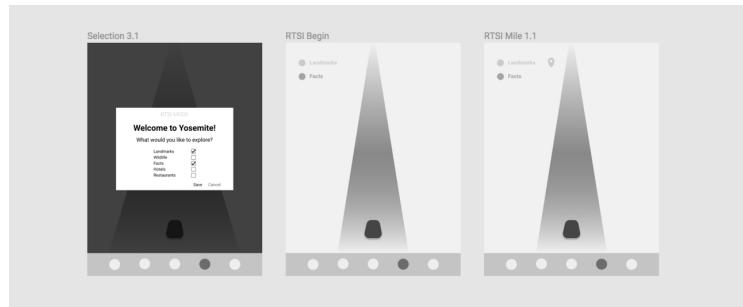
## Curious Cameron

I wanted to highlight the RTSI feature's touchpoints, and so I did this through simple visual design: I made the interface primarily grayscale, only using color for the touchpoints and the legend associated with them. Thus, I tried to entice interaction with the touchpoints, as to draw their eye to them with the use of color. Before doing that, I created a low-fi to do some internal user testing, just like I did for the immersion interface.

Like before, I made mid-fis that I would pass on to the software team to develop for user testing. You can find our CC Interface's prototype [here](#).



*CC Interface mid-fi's.*



*Low-Fi's of the CC Interface.*

## Simulation Development

In order to move forward with usability testing, we needed to develop our simulation environment. We conducted usability testing for our immersion experience at two different events:

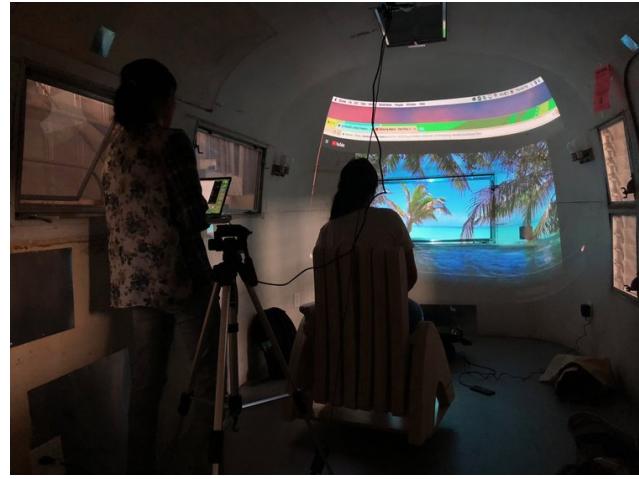
- 1) **The International Symposium for Academic Makerspaces (ISAM) Conference**
2. BRAVO's first Demo day

We all worked together to create this, spending countless hours in the airstream at a time setting up projectors, 3D-printed walls, and rails. My main role in this was **projection mapping**, using Madmapper to smoothly merge the video three projectors to **create an effective 180 degree visual experience**.

*You can read about our ISAM experience [here](#), and about BRAVO's first demo day [here](#).*



*Final iteration of projection, with smooth 180 degree visuals!*



*First iteration of projections in the airstream.*

## User Testing

After setting up the simulations for each respective event, we were ready for user testing. We had the following key questions that we wanted to get out of testing:

1. How was the **usability of the mobile interfaces?**
2. Would people enjoy the **customizability of the experiences?**
3. Would the participants be able to intuitively understand the **context of the scenarios?**



*User testing @ ISAM Conference*



*User testing @ BRAVO Demo Day*

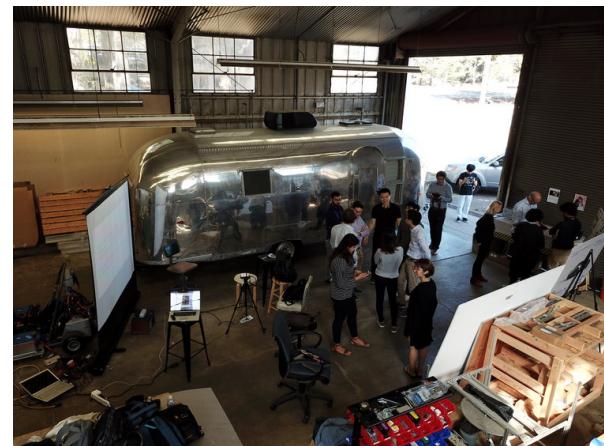
Overall, feedback from the immersive relaxation experience was very positive! Some key insights from the testing are as follows:

1. Among older audiences, the SS interface wasn't as straightforward to navigate through: In one instance, an older man **accidentally saved the preset after**

- naming it, and without putting the actual sensory experiences first.
- 2. People actually confused the two scenarios as actually being a single scenario.
    - This shows potential in having only a single scenario that incorporates ideas from both SS and CC.
  - 1. After inputting options into both interfaces, people would lift their head to see if the visuals had changed; **a change in gaze that requires lifting of the head**. This was especially an issue in the CC interface, as clicking the touchpoints weren't intuitively connected to the purpose of the RTSI.

## Reflections

Our summer work concluded with our BRAVO demo day presentation, which was an amazing experience! It was so fulfilling seeing our hard work at work, and seeing the great reactions we got from accomplished people in the AV field. You can find some more cool pictures from our event [here](#).



I, as well as many undergraduates from the summer team, are continuing our work into the fall semester as student researchers. **This Fall, we plan on:**

1. Continuing to **user test and iterate**.
2. **Combining the two scenarios** we developed this past summer into one, general road-trip experience.
3. Developing a **mixed reality system** to account for changes in gaze and experimentation with flexible interior layouts.
4. **Write a paper** on our findings from the summer work.

Special thanks to Alice Agogino and Euiyoung Kim for putting so much trust in us, and for being amazing mentors throughout the entire process. Please look forward to future work from the undergraduate BRAVO team!

*You can learn more about the BRAVO Group [here](#).*