SDA 490: Autonomous Vehicles Journal Article

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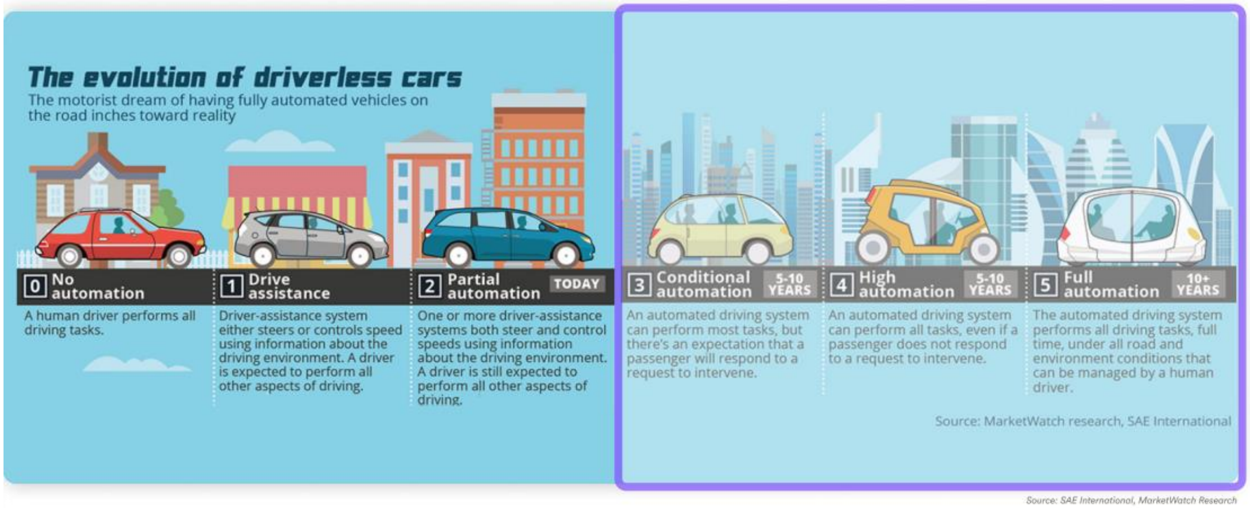
The City of Vancouver has proposed a goal to make 33% of all trips to be either walking, biking, or transit by the year 2040. In doing so, the aim is to reduce the amount of congestion on the roads in the city, and ultimately create an urban design that supports and encourages environmentally friendly planning and safe travel for all people in the city. In projecting into the future, the City of Vancouver must also consider the impact that Autonomous Vehicles (AVs or also known as Self-Driving Cars) will have on the roads. The city of Toronto, for example, already has a detailed plan that considers the future of AVs and how they may change and impact travel. Our project's goal is to consider how Autonomous Vehicles will impact the future landscape of roads and travel within the City of Vancouver. We will be looking at data that shows acceptance of AVs. We are looking into this data because the degree to which the general population views AVs as safe, efficient, and necessary is essential in understanding how likely the adoption of this form of travel is. Second, we will also be looking into data that explores the amount of street parking on roads in Vancouver. We are looking into this because assuming AVs will be perfectly driving vehicles once achieving level 3-5 autonomy, a need for street parking is decreased as the cars can simply drop off their passengers and either merge into traffic until their passenger needs a pickup, or further parking lot infrastructures may be built to support AVs. Additionally, because these vehicles are perfect driver, parking spots may also be reduced in size, also adding to the effect of increased space in the city. This has massive implications for the future of travel in the city. If street parking is rendered as inessential, this opens up a plethora of possibilities in terms of what can be done to roads and space in the city.

To justify the proposition that AVs are important and necessary for the city to consider for the 2040 goal, it is essential to assert projections of the percentage of cars that will be electric. Here, we are choosing to look at electric vehicle projections (especially Tesla), as electric vehicles such as Tesla have the ability to update their software. This means those who already own Teslas, will not have to return their cars or buy a new one to receive self-driving technology—they simply wait for their existing car that sits in their garage to receive the update. This being the case, we can safely assume that at the very least, the majority of Tesla Electric Vehicles will also be Autonomous within a given time frame. It is expected that within 10 years, a large percentage of electric vehicles will be autonomous. The percentage of sales of electric vehicles is already increasing at a rapid rate, and policy decisions being made by certain governments represent this shift. For example, the Biden administration has set a goal to have 50% of all vehicle purchases be electric vehicles by the year 2030. Additionally, California has a goal for all vehicles that are sold to be zero-emission by the year 2035. Canadian governmental support and policy decisions made towards the encouragement of electric vehicles have also had a large influence on the prospective future of this travel in Canada. For example, the Canadian government has allocated $130 million over five years, starting in 2019-20, to build EV charging and refuelling stations across the country. This funding is part of the government's broader efforts to reduce greenhouse gas emissions and accelerate the adoption of zero-emission vehicles in Canada.

Our project focuses on high-level autonomous vehicle functioning. Below is an image describing the levels of AVs.

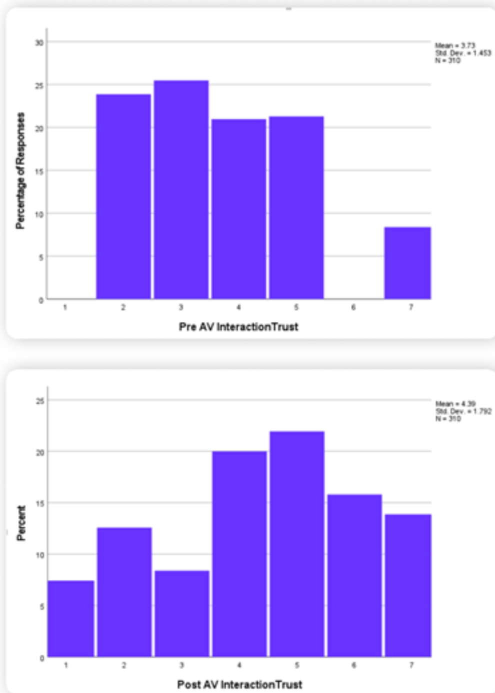


The levels range from zero to five, where zero is the level where the human performs all tasks and five represents full automation with the car responsible of everything. Here, our interest is in levels three and above as these are the levels that will be relevant to the 2040 transportation goal. It is assumed that the percentage of vehicles that will have the capability to drive autonomously will vastly increase within the next five to ten years.

A speed bump that may be present in the implementation of AVs into society will likely be the public's perception of the technology. The degree to which they accept, adopt, and trust the new technology will be a very important factor in how AVs impact society. To explore this relationship further, we gathered a data set that looked at opinions and attitudes towards AVs before and after an interaction with one. In this data set, there 310 participants answered pre and post questions regarding their attitudes to autonomous vehicles. A specific measure we focused on was trust of driverless vehicles, before and after an interaction. Below, a distribution of the responses can be found along with a statistical analysis of the significance of the change.

Respondents' Trust in Autonomous Vehicles Before and After Interaction

On a scale from 1-7 (Strongly Disagree - Strongly Agree)



Paired Samples Statistics

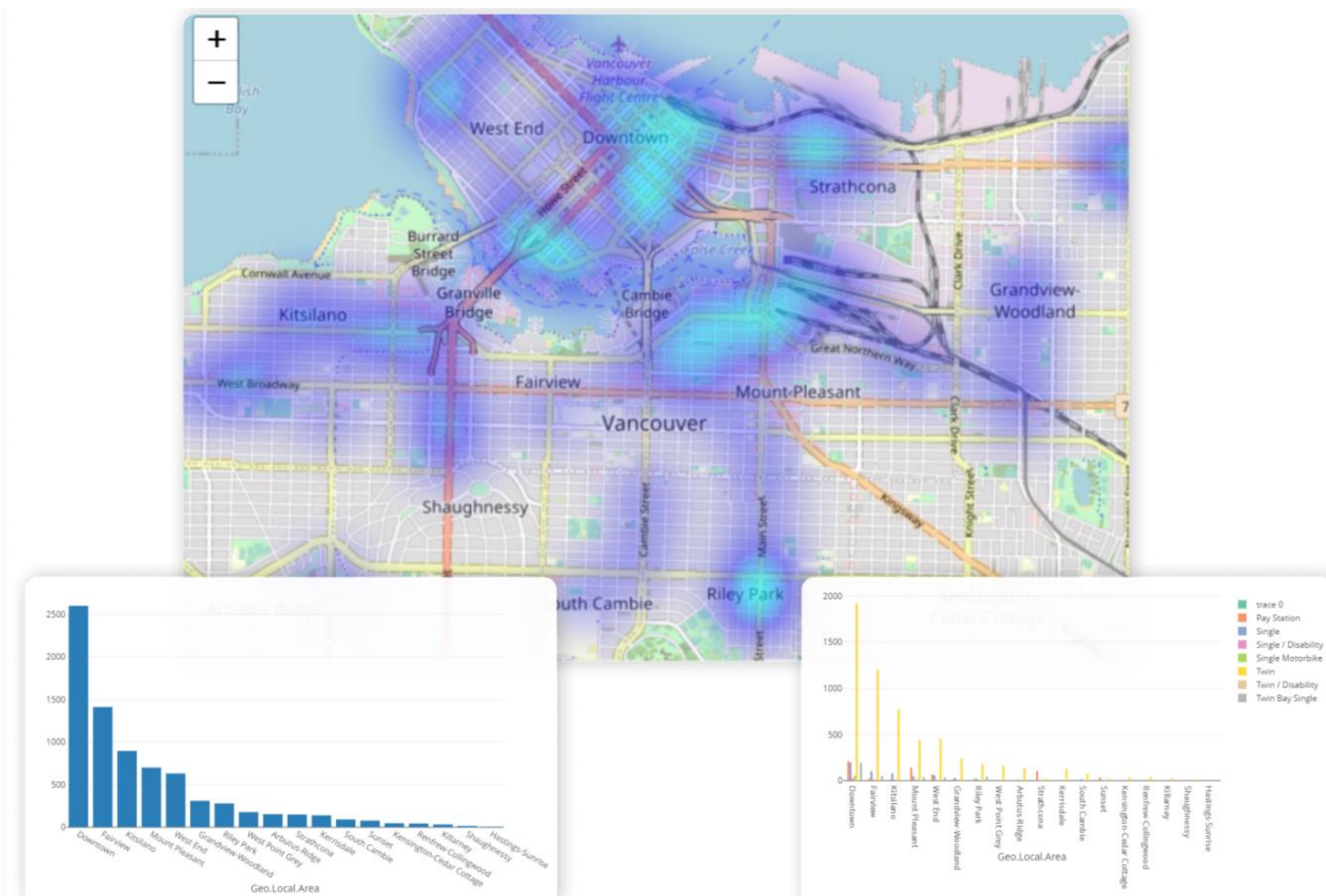
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreAVTrust	3.73	310	1.453	.083
	PostAVTrust	4.39	310	1.792	.102

Paired Samples Test

		t	df	Sig. (2-tailed)
Pair 1	PreAVTrust - PostAVTrust	5.507	309	<.001

Here, these graphs tell us how trust in AVs changes after an interaction with one. The top graph represents pre-interaction, while the bottom graph shows us post-interaction. The scale is from one to seven, with one indicating the lowest level of trust, and seven indicating the highest level of trust. Solely based on an eye test, there is a clear shift towards the right of the bar graph, telling us that levels of trust may be higher after an interaction. In order to determine whether this is a statistically significant relationship, a paired samples t-test was run. The results of the test were statistically significant, with the test garnering a p-value of less than 0.001. What this tells us is that exposure to autonomous vehicles and interactions with them are essential in increasing the trust one feels towards the new technology of driverless vehicles. Being that the shift from being in a moving vehicle controlled by a human to one controlled by a computer can be quite jarring, we conclude that the city will find it extremely useful to implement programs and opportunities for their citizens to be able to interact with AVs. This will create a smoother transition into the inevitable introduction of driverless vehicles on our roads.

In order to dive into our hypothesis that Autonomous Vehicles can reduce the need for on-street parking, we analyzed the number of on-street metered parking within the Vancouver city area. Below, a heat map of the most densely packed metered street parking areas in Vancouver is shown, along with bar charts showing which areas have the most metered street parking.



The map, along with the bar graphs tell us that the downtown area has a highly dense packing of metered on-street parking. Being that downtown is an area of high foot and vehicle traffic, this is very relevant to us. What can be done regarding these parking spaces if AVs were implemented? The possibilities open to the city are plentiful. We wanted to determine how much space is taken up by these parking spots in the city, so we took our data and further analyzed it.

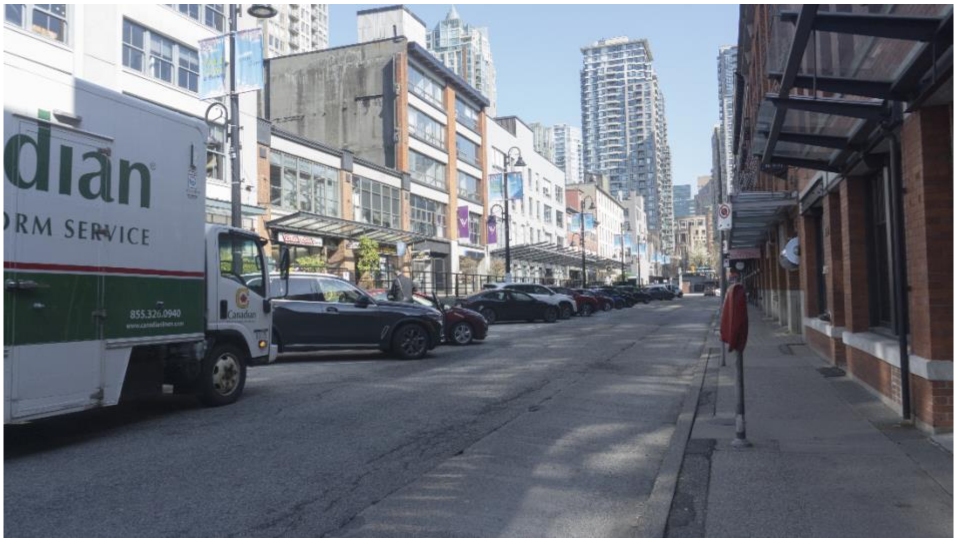
Our analysis consisted of determining the amount of square footage that is taken by each parking space. In Vancouver, the approximate square footage of one street parking spot is about 160 square feet. Given there are approximately 12, 000 metered parking spots in Vancouver, this comprises approximately two million square feet of space solely taken up by metered street parking. This can also be represented as 34 football fields, which is shown in the image above with the pink shaded area over the city of Vancouver. This takes up a very significant space of the city and shows there is much room to play around with. The yellow shaded area over the same image of Vancouver represents the amount of space taken by metered street parking solely in the downtown area. This is represented as 11 football fields. It is also necessary to note that this space is only representative of 5% of all of the street parking in Vancouver. In total, there are approximately 250 thousand street parking spots. Visualizing this through our maps presents a shocking realization of how much space in the city is occupied solely by street parking—and it is even more shocking when we reiterate that this is only 5% of all street parking in the city. This tells us that there is a huge realm of possibilities for the city in terms of expansions to roads, sidewalks, and business/economic opportunities. The introduction of AVs has the potential to allow the city the opportunity to repurpose this space and create road networks that make Vancouver a more efficient and livable city.

In light of our data analyses and graphics, we decided that the elimination of on-street parking spaces and repurposing these spaces into pedestrian-friendly infrastructure would be in line with Transport 2040 goals. As we assume that AVs can drive perfectly and park efficiently, parking spaces can be made narrower and clustered closer or eliminated altogether. The spaces that are freed up can now be used to expand bike lanes or create a larger sidewalk, incentivizing folks to walk or bike to where they need to go.

Guided by our parking meter heatmap, we decided to take a look at what the current parking spots looked like and whether or not its elimination would actually do good. We took photos of areas of interest to us and edited them to help visualize our team's goals and potential uses of these spaces.

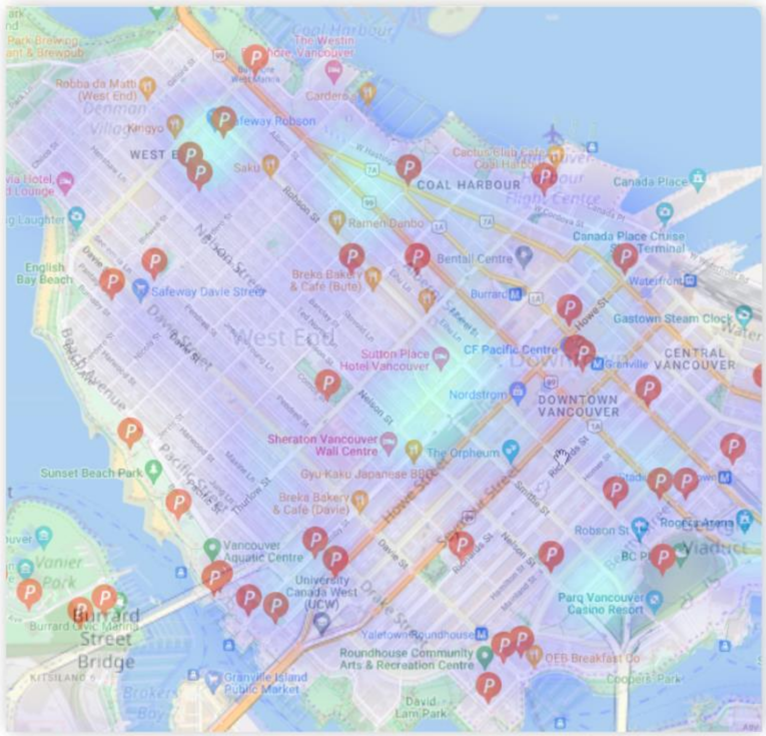
Our first area of interest is closer to a residential area in downtown. There is currently construction happening, and the street itself is only one way and one lane. There is on-street parking, as well as a bike lane. As you can see in the above photo, parking takes up quite a bit of the road, especially with large trucks.

Now if we were to take this parking out? The bike lane can be extended outwards, and visibility increased making it easier for AVs to respond to jaywalkers, bikers, or other unexpected situations. Wider sidewalks and more spaces to sit invite people to come out and larger bike lanes encourage more biking.



Our next area of interest is Yaletown, which has a large amount of paid parking (as seen in the above heatmap!) Yaletown has these large areas of paid parking all along the side of the road. Cars are parking in a diagonal formation, fitting more cars in an area, but at the expense of road space and pedestrian space. You can also see on the right side of the photo that the sidewalk is quite narrow, making it difficult for people to enjoy their stroll and look at stores.

If we were to take out the parking area, patios can be put in, and entertainment areas can thrive. Drop-off and pick-up zones can also be established, making it safer for couriers and deliverers. The sidewalk can also be widened, giving space for people to window shop and peer into the multitude of small businesses in Yaletown.



And of course, the big question is – where do the cars go if there aren't any parking spots? After the passenger gets dropped off by their AV, the car can be programmed to head to the closest EasyPark garage to park and wait for their passenger. Since parking spaces can be narrower, this means that garage capacities can be increased, keeping more vehicles off the roads. Our team specifies EasyPark because they are a non-profit City-owned company, and parking fees can be split amongst the city and leaseholders, ensuring that the City still receives revenue from parking. There are currently 6,030 parking spaces across downtown EasyPark garages, enough to replace the 2,616 metered spots that we are removing. We believe that there are enough spaces to meet demand, especially if the garages are upgraded and expanded.

Our team believes that with the advent of driverless vehicles, cities will be free to repurpose existing street space to make room for pedestrian-friendly infrastructure. Autonomous cars offer the luxury of close to perfect driving, meaning that parking spaces can be outright eliminated and used for other activities like wining and dining, public art and performance, or in a practical way like pick up and drop off zones for passengers and couriers. The removal and repurposing of parking spaces means that pedestrians and bikers have room and freedom to walk and bike to enjoy their city at their leisure, in line with the City of Vancouver's Transport 2040 goals.