Policy Memo:
Autonomous vehicles and land use in Vancouver, Washington

Discussing the potential of autonomous vehicles has been all the rage for several years- and not just in planning and transportation circles, but among broader sections of the public as well. The next generation of cars promises to reduce CO2 missions, increase productivity, eliminate congestion, and make roads safer for everyone regardless of modal choice. In *Metropolitan Transport and Land Use,* authors Levinson and Krizek suggest that autonomous vehicles won't just change the automobile, but the costs of traveling, the prices of housing, and the designs of our streets. In short, "autonomous cars are important not just as a replacement for existing trips, enabling travelers to do things while in motion, but as a way of changing *travel*" (Levinson and Krizek, pg. 264).[1] Lost in this surge of excitement is the discussion of how we draw up land use plans for our cities with consideration for a new mode that will radically change commuter behavior.

While academics have been having this conversation for years, it seems as if the media is also beginning to catch up. On June 6th, 2019 *Forbes* published *Autonomous Vehicles: To Park or Not to Park?*[2] This op-ed from an AV industry professional delved into several aspects of how the impending transportation revolution will affect land use planning. One of the more interesting conclusions in the article comes from an estimation that it will cost just 50 cents per hour to operate an AV in a city, compared to an average $6 per hour for parking, and "with numbers like that, it could be much more cost-effective for vehicles to cruise around empty or to return home or to depots rather than to park- in either case adding to congestion." Word is getting out that AVs will not only provide a staggering number of solutions for congested cities, but also the potential for a similar number of new headaches for policy makers and planners.

Another article published by *CityLab* on May 30th, 2019 asked *Why Aren't Cities Getting Ready for Autonomous Vehicles?*[3] This piece summarized a *JAPA* study that found nearly all American cities are lacking a plan for AVs, and many of them are waiting for guidance from a higher authority in their State or Federal governments. While neighboring Portland has a set of policies for "connected and autonomous vehicles"[4] and WSTC has set up a work group[5] to prepare for AVs, Vancouver does lacks its own policies and plans. But how should Vancouver prepare itself and when exactly are AVs expected to arrive? Government bureaucracies work slow and tend to be reactive, and until these questions are addressed there is little reason to expect a boom of land use plans featuring AV considerations. The rest of this paper attempts to answer those questions for the City of Vancouver.

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1 Krizek, K and Levinson, D. (2018) *Metropolitan Transport and Land Use: Planning for Place and Plexus.* Routledge 270 Madison Avenue, New York, NY 10016. ISBN10 0–415–77490–X (hbk)

2 Forbes: https://www.forbes.com/sites/forbestechcouncil/2019/06/06/autonomous-vehicles-to-park-or-not-to-park/#44c2164d692f

3 CityLab: https://www.citylab.com/transportation/2019/05/autonomous-vehicles-city-regulations-traffic-self-driving-car/590440/

4 City of Portland: https://www.portlandoregon.gov/transportation/article/643814

5 Washington State Transportation Center: https://wstc.wa.gov/Meetings/AVAgenda/AutonomousVehicleWorkGroup.html

The current and projected status of AVs:

There are several big-name auto companies in the US that have been experimenting with autonomous vehicle technology for several years at this point. In April 2019, Elon Musk claimed that Tesla would have "over a million cars with full self-driving, software… everything" by 2020.[6] But before going into what the automotive industry is telling the market, it is important to understand what we mean when we say "autonomous."

According to the Society of Automotive Engineers and the National Highway Traffic Safety Administration, there are five levels of vehicle autonomy, starting from "level 0" to "level 5."[7] Unsurprisingly, 0 means no automation and the driver has complete control of the vehicle at all times. However, a 0-level vehicle may be equipped with technology that AVs also use, including a street scanner that can warn the driver of another car in their blind spot. At level 1 the driver is still in control, but one of the functions is automated (e.g. cruise control). At level 2, the vehicle controls two driving functions at the same time (e.g. cruise control + lane changes). Level 3 means the vehicle can drive itself entirely, but only in certain areas or specific parts of the trip (e.g. highways, but not neighborhood streets). It isn't until level 4 when the vehicle can drive itself for entire trips, but it requires certain conditions (e.g. a pre-mapped environment). At level 5, the vehicle can operate by itself anywhere and without any passengers. When he made his announcement in April, Musk used the term "robot-taxis." Based on that phrasing and other information Tesla has released to the public, it seems likely that Tesla is hoping its "self-driving" vehicles will be operating at level 4 by next year.

While this may be true, the nationwide rollout of AVs above level 3 will likely take at least a decade, according to an American Planning Association report titled *Planning For Autonomous Mobility*.[8] In the report Crute et al note that the other automakers stating they will be putting AVs on the road by 2020 or 2021- including GM, Ford, Volvo, and Waymo- are similarly referring to level 4 vehicles. The research collected in Crute et al's report suggests that level 5 vehicles will not be available on the market until 2025 at the earliest, with some suggesting 2030 or beyond. This may seem distant, but once the rollout begins research suggest that AVs will quickly take control of the market. Some studies cited in the report claim that AVs will make up around a quarter of the vehicle fleet by the mid-2030s. Several more estimate that number will climb to 50 percent around 2050. While Crute et al. point out that the most optimistic studies when it comes to AV adoption were published in the earlier 2010s, and therefore had less information to work with, they make it clear that "by and large, the technology is advancing much faster than the regulatory framework AVs operate within" (Crute et al, pg. 24).

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[6] The Verge: https://www.theverge.com/2019/4/22/18510828/tesla-elon-musk-autonomy-day-investor-comments-self-driving-cars-predictions

[7] National Highway Traffic Safety Administration: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

[8] Crute et al. (2018) *PAS Report 592: Planning for Autonomous Mobility*. American Planning Association Planning Advisory Service. ISBN: 978-1-61190-200-6

How AVs could influence transportation demand and land use, and the benefits and costs of three possible outcomes:

Depending on how they are introduced to cities, AVs could lead to a substantial decrease in the costs of traveling and congestion, but that is largely dependent on the role Mobility as a Service (MaaS) models play in the rollout. If most AVs are privately owned, then there is a strong chance that, rather than waste time looking for parking, AV owners will either send their car home or have it drive around in circles while they work, shop, or engage in other activities. This theory is based on Wardrop's Principle of User Equilibrium (Levinson and Krizek, pg. 78), which states, "The journey times in all routes actually used are equal and less than those which would be experienced by a single vehicle on any unused route." In essence, drivers behave selfishly when they travel- always searching for ways to shave off minutes from their commute time. If they can avoid wasting time "cruising" for parking by sending their AV home, they will, regardless of the overall impact on the rest of the transportation system. This could more than double the VMT for every trip taken by a person and create massive congestion problems in the process. In this scenario, it is conceivable that the demand for more parking in cities and highway expansion will skyrocket to compensate for the increased congestion. This scenario might also increase the demand for off-road transit alternatives (rail), transit malls, and denser development in some places (for people trying to avoid the traffic altogether), but the dramatic increase in the number of vehicles driving around at all times will likely result in a noisier and more polluted Vancouver, even in suburban neighborhoods and even if all AVs are electric.

However, if policies are created that encourage MaaS models and discourage private AV ownership, it is possible that the drop in the costs of travel will cause an increase in the demand for transportation without an subsequent increase in vehicles on the road (although the number of trips each car will take will increase). It is important to note the costs that will drop won't only be the dollar price for driving somewhere, but also the cost of not being able to do anything (work, sleep) while using a car. In this scenario the decrease in the number of privately owned automobiles will also lead to a decrease in the demand for parking, so cities might be able to reclaim many of their streets from the automobile and create more pedestrian-oriented environments through plazas and wider sidewalks.

A MaaS-dominated future for AVs does not seem all that unlikely considering the rise of rideshare services like Lyft and Uber, which operate essentially the same as an AV taxi service would. Some research suggests an AV taxi service would be even more convenient and cheaper than the Lyft/Uber model, "given the fact that the driverless taxi obviates the need for annual fixed costs and maintenance normally associated with car-sharing as well as parking."[9] While this is true, the demand for maintenance and parking will not evaporate entirely, and land us planners will have to consider how the location AV infrastructure like massive depots might impact congestion and VMT.

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[9] Bagloee, S.A., Tavana, M., Asadi, M. et al. J. Mod. Transport. (2016) 24:284: https://doi.org/10.1007/s40534-016-0117-3

In both the private and MaaS models, AVs will also make it easier and more affordable to commute longer distances, creating a serious headache for regional planners trying to create denser and more sustainable urban centers. While Vancouver has an "urban growth area" that will help counteract the forces pulling development outwards, its design may not be adequate for regulating sprawl in an AV future.

Urban growth boundaries (UGB) are an obvious option for mitigating the negative land use affects of an AV dominated system. By restricting housing development in rural, agricultural, or natural reserves, AV users will not be able to take advantage of the reduced costs of long commutes. That being said, the UGBs in Washington and Oregon were designed to counteract a specific type of sprawl in which there are still time and energy costs with long commutes. With AVs these costs are dramatically reduced, making it possible for people to commute for many more hours than they would normally drive. According to Alonso's Bid-rent function (Levinson and Krizek, pg. 48), developers will likely purchase cheaper land in smaller towns or rural parts of the state, knowing that they can still advertise it as within a comfortable commute distance to Vancouver via AV. Housing consumers will move out to these distant locations because low-density housing is still associated with a higher quality of living. This process will create a new relationship between UGBs in which place doesn't matter. In this future, the housing market in Vancouver could collapse even as more and more commuters take advantage of its job market and economy. Congestion might stretch for miles along once empty highways and small towns could become overwhelmed by residents who work and shop hundreds of miles away. The benefits of this scenario would be that housing prices would drop across the state, but the costs to the environment and local economies would be at least as dramatic.

Historically, UGBs have been viewed as tools to protect the natural environment outside cities, but not necessarily as tools to improve urban life. As a result there are frequent mentions of the tension between restricting suburban development and the consumer demand for more suburban housing. It is critical that Vancouver takes advantage of the ability of AVs to improve urban environments by reducing the number of cars within them, thus increasing the amount of space for people while decreasing air and noise pollution. This might begin to flip the script on why suburban living is more desirable.

Policy and planning options for addressing the possible land use effects:

The good news for planners and policy makers is that there are many options for addressing the potential negative effects of AVs, and some of them are already being used to address other transportation challenges. These include ways to rethink parking (replace street parking with drop-off zones, price parking spots using the Donald Shoup method[10]), issuing permits and fees (as is the case with most scooter and bikeshares), and reprioritizing rights of way (create more transit malls and allow MaaS AVs to operate on them). A more complete list can be found in the PAS report, but two of the most useful tools for Vancouver are listed below.

The first tool policy makers and planners should use to encourage a MaaS future over privately owned AVs is congestion pricing, which has already been tried around the

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[10] Shoup, Donald (2005). *The High Cost of Free Parking.* APA Planners Press: ISBN 978-1884829987.

world and may be coming to Portland's I-5 corridor soon. An oft-cited existing model of congestion pricing can be found in London, where the central parts of the city have been turned into a "Congestion Charge Zone." In order to reduce congestion and increase transit use, the city began charging motorists a substantial sum to enter Central London in 2003. Today the price is around £11.50 GBP, or $15 USD, per day. This program "resulted in a 17 percent reduction and a 16 percent increase" in congestion and transit, respectively (Levinson and Krizek, pg. 91). A pricing plan like London's could be adapted to give discounts (or forego charges entirely) to MaaS riders, while also raising the costs for private AV ownership by charging owners every time their vehicle crossed a marked perimeter. While this solution would discourage private AV owners from sending their vehicles home without passengers, it unfortunately does not prevent them from sending their AVs on a continuous loop around the neighborhood while they engage in other activities.

Secondly, policy makers and planners should switch from focusing on the Level of Service (LOS) to reducing the Vehicle Miles Travelled (VMT) when drafting transportation plans. LOS, which focuses on reducing vehicle delay rather than trip times and/or counts, was the preferred measurement when VMT and economic growth were seen as inextricably linked. Fortunately "data from the past two decades shows that economic growth is possible without a concomitant increase in VMT."[11] Since the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) was passed in 1991, transportation planning has been refocused on addressing "the non-efficiency aspects of transport" (Levinson and Krizek, pg. 157). When it comes to planning for AVs, VMT models are superior to LOS models as they "plan for trips and trip length while not penalizing dense urban development through the environmental review process by allocating them greater numbers of auto trips than more suburban developments with fewer people" (Crute et al, pg. 58).

How MPOs and cities need to alter the tools and analyses they use:

While the introduction of AVs is likely to come with a great many surprises that will force policy makers and planners to think on their feet and innovate in record time, there is one change that we can prepare for: 5G. Based on media reports and marketing material from automakers, is clear that the rollout of AVs in urban environments will be paired with the introduction of 5G. In its Smart Mobility Roadmap, the local government of Austin, Texas has already made plans to "test 5G technology for vehicle to infrastructure (V2I) reciprocal safety messages"[12] This parallel development in telecommunication technology is crucial for planning for AVs two reasons: it allows planners to redesign and upgrade infrastructure with technology that can work with and mitigate the negative effects of AVs, and it creates a whole new universe of data sources.

AVs will undoubtedly raise countless questions about their impact on the built environment, and the rise of 5G could provide planners the datasets they need to answer

[11] Governor's Office of Planning and Research (2018). *Technical Advisory (SB 743), Pg. 3*: http://opr.ca.gov/docs/20190122-743_Technical_Advisory.pdf
[12] Austin, TX, Smart Mobility Roadmap: Austin's Approach to Shared, Elec-tric, and Autonomous Vehicle Technologies (2017) www.austintexas.gov/smartmobility roadmap

those questions. In theory, 5G will allow the "smartification" of city infrastructure, allowing "vehicle to everything" (V2X) communications. Stop signs, lampposts, stop lights, and sensors in the ground or even floating in the air via drones will be able to communicate with AVs, and city government could study those communications to inform themselves on how to plan around the most precise transportation data ever recorded. In order to get the most out of this technological breakthrough, planning departments will require more funding to both install smart infrastructure and pay for larger data analysis staff. One thing that is important to consider, however, is the impact that AVs and 5G infrastructure on privacy. Big data comes with its own lengthy list of ethical concerns, but policy makers and planners should begin preparing our tools and analyses for the AV future by figuring out how will collect data (what infrastructure), how much data we will collect, how we will use that data, and who else should have access to it.

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