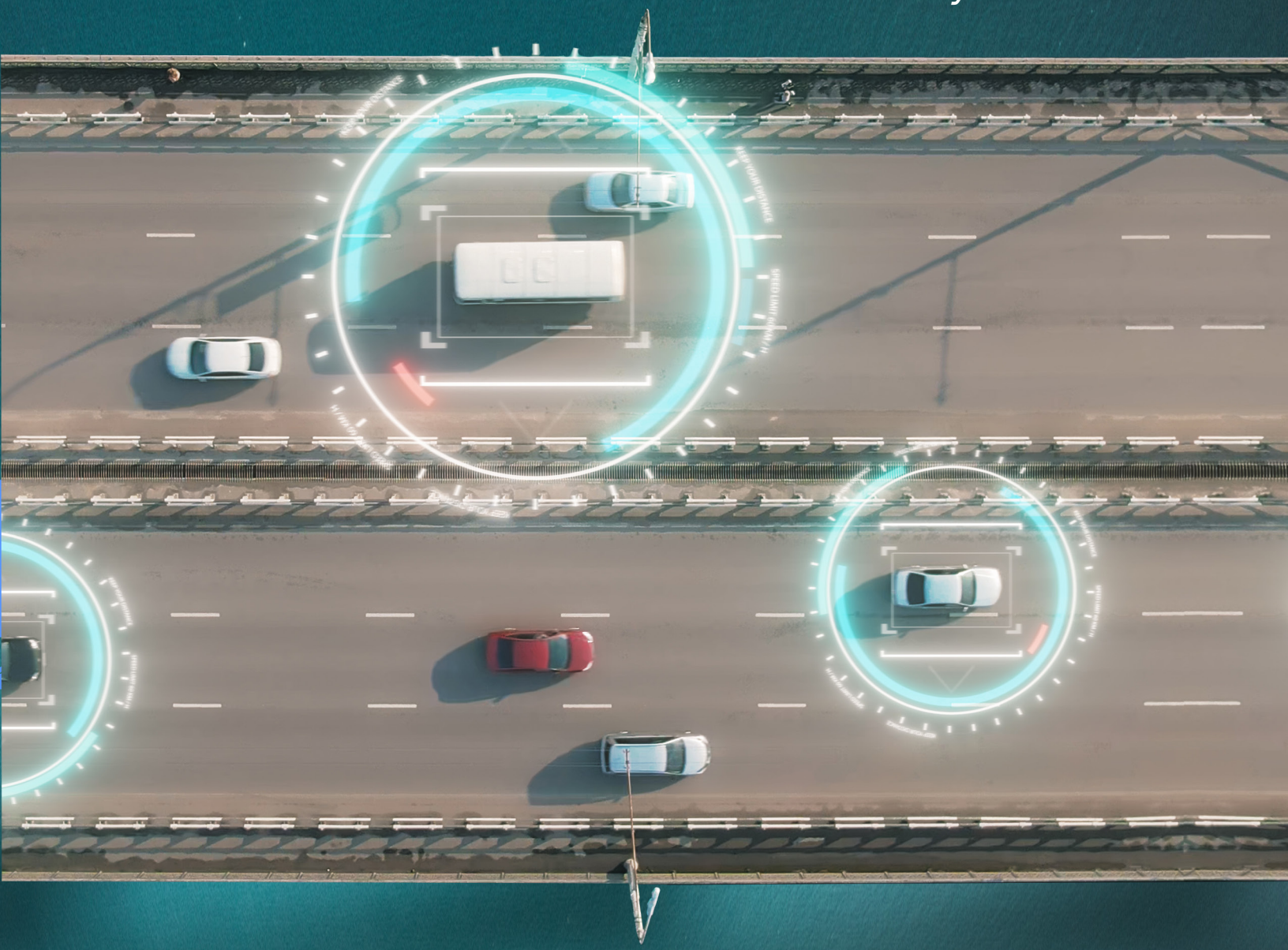
Report

AUTONOMOUS VEHICLES: Leveraging Technology for Diverse Community Benefit

By Brian Woolfolk



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Autonomous Vehicles: Leveraging Technology for Diverse Community Benefit

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01 Introduction

Where you live unfortunately can define your quality of life, your access to food, how safely you commute, and how easily you access healthcare or job opportunities. Geographic isolation borne of discrimination has led to food deserts, medical access challenges and traffic safety disparities. Fortunately, new technology presents an opportunity to address these issues. Autonomous vehicles (AVs) are a potential tool to tangibly reverse the effects of geographic isolation and to provide remedies to some of the most significant challenges confronting minority communities.

Autonomous vehicles offer many potential solutions to problems confronting minority communities. These benefits are often ancillary to the primary focus of the technologies. But, they are significant and even transformative to the impacted communities.

The original local deliberations regarding ride-sharing companies vs. legacy taxi cab companies are a prime example of a policy discussion that might have looked different if the benefits to diverse communities were more prominent in the debate. These disputes mostly focused on the economic issues relating to competition between taxi medallion holders and the new entrants, ridesharing companies that threatened the medallion holder companies' market share. Deliberations failed to sufficiently account for the issue of cab-hailing discrimination against Black customers. A District of Columbia study found that Black customers were seven times less likely than white customers to have a cab stop for them.[1] Ridesharing companies have transformed the ability of minority communities to access transportation.[2] Autonomous vehicles present many similar transformative benefits that should be articulated and supported.

[1]Macdonell, J.' Liban, V. (2003, October) Responding to Taxicab discrimination in the District of Columbia. The Equal Rights Center. https://equalrightscenter.org/wp-content/uploads/taxicab_report.pdf

[2]Brown, A. (2018). Discrimination in Ridehail and Taxi Services. Institute of Transportation Studies. University of California. https://www.its.ucla.edu/wp-content/uploads/sites/6/2018/12/Brown_Discrimination_in_Ridehail.pdf

Geographic isolation is at the root of many different problems facing minority communities. A disproportionate amount of minorities live in communities with limited access to healthy foods, medical care and employment opportunities. These communities also face transportation ecosystems that are unreliable and unsafe. In addition, minority communities suffer disproportionately in nearly every category of traffic safety.[3] Autonomous vehicle systems, if properly deployed, will address these issues by providing significantly greater access to healthcare and jobs by providing safe, reliable and affordable transportation beyond current constraints. Although these potential benefits are often overlooked, it is important that stakeholders work together to ensure that these opportunities are aggressively pursued.

02
Autonomous Vehicles

Autonomous vehicles are broadly defined as vehicles with functions that can operate without human direction.[4] Their innovative technology utilizes machine learning and advanced sensors to operate. The AV will "see" 360 degrees, sense obstacles, and pedestrians and anticipate the movement of other vehicles and people. Autonomous vehicles will not get tired, distracted or impaired. Multiple companies are testing AV technologies and field testing AV systems.

The Society of Automotive Engineers created a widely accepted 6 level AV characterization system.[5] This system classifies AVs from Level 0 (no automation) to Level 5 (a self-driving vehicle capable of driving on any road). This paper focuses on Level 4

[3]Retting, R. (2021, June). An Analysis of Traffic Fatalities by Race and Ethnicity. Governors Highway Safety Association. https://www.ghsa.org/sites/default/files/2021-06/An%20Analysis%20of%20Traffic%20Fatalities%20by%20Race%20and%20Ethnicity.pdf

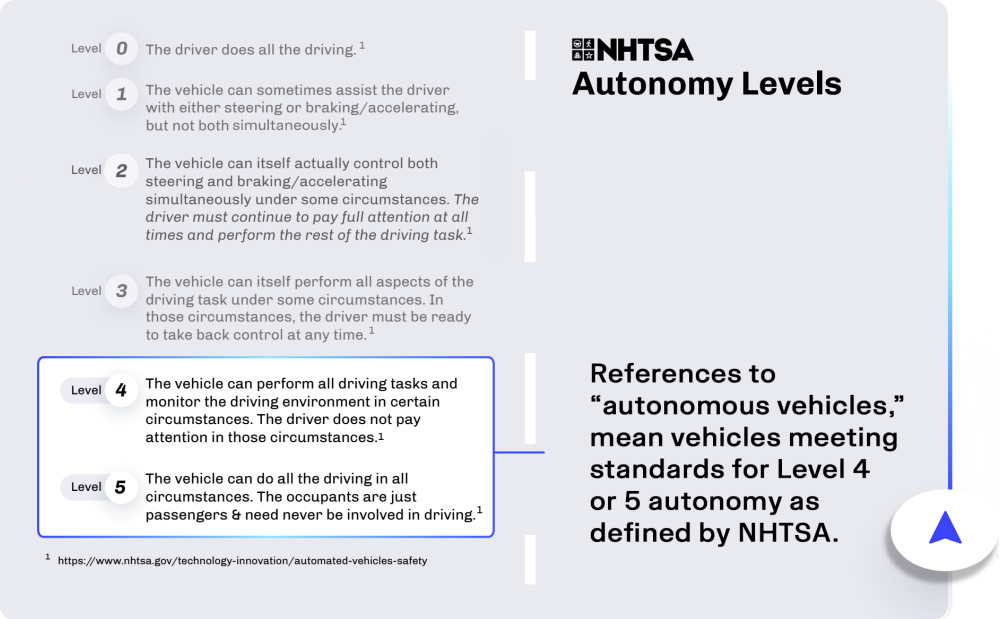
[4]Center for Sustainable Systems, University of Michigan. 2021. Autonomous Vehicles Factsheet. Pub. No. CSS16-18. https://css.umich.edu/factsheets/autonomous-vehicles-factsheet

[5]NHTSA. Levels of Automation. https://www.nhtsa.gov/sites/nhtsa.gov/files/2022-03/Levels_of_Automation_Static_022822-v4-tag.pdf

(self-driving vehicles in limited areas) and Level 5 autonomous vehicles. Current estimates predict autonomous vehicles will reach widespread level 5 deployment by 2030.[6]

As technology rapidly advances to Level 5 AV deployment, policymakers face significant challenges in creating a regulatory environment capable of adequately protecting community interests while facilitating growth. New laws and regulations will be necessary in liability, motor vehicle law, traffic safety and criminal justice. In addition, some consistency or preemption may be necessary to prevent a hodgepodge of state and local regulations that could potentially stunt AV growth.

The evolution in regulatory regimes will in many ways be just as large a factor in equitable deployment as advances in technology. Regulatory regimes that slow AV deployment or increase operating costs could have significant negative effects on accessibility.[7] These impacts should be considered as policymakers design new accountability and safety systems.



[6]Heineke, K., Heuss, R., Kampshoff, P., Kelkar, A., Kellner, M. McKinsey Center for Mobility. (2022, January 3). Our Insights: The Road to Affordable Autonomous Mobility. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-to-affordable-autonomous-mobility

[7]Heinke, Note 6.

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03

Application of Equity Principles to AVs

As transportation systems evolve towards automation, these systems will need to be intentional in ensuring underserved communities enjoy full participation and benefit of the new technologies. Advancing accessibility is a key component of AV equity. Fortunately, there are significant efforts to not just ensure equal access to AV systems, but also to leverage future AV systems to counter past inequities.

Transportation insecurity is a measure similar to food insecurity.[8] Transportation insecurity is an analysis of how both communities and individuals are able to access transportation. Significant portions of underserved communities do not own their own vehicles and lack sufficient income to access private transportation. Due to the rising costs of walkable urban living, many of the same peoplehave been priced out of transit-oriented or adjacent developments. This diminished mobility deeply affects nearly every facet of life: health, education, jobs, and food access.

Autonomous vehicles, if properly deployed and supported, have significant potential to address transportation insecurity issues. In order to substantially realize equity benefits, equity will need to be a central element of design and deployment.[9, 10] The prioritization of deployment to ensure early participation in underserved communities, for example, will help efforts to avoid redlining. In

[8]Tealey, C. (2018, June 18). How AVs could be a boon to transit equity and efficiency. SmartCitiesDive. https://www.smartcitiesdive.com/news/autonomous-vehicles-transit-equity-efficiency/525921/

[9]Transportation Research Board. (2020, September 21). Preparing for Automated Vehicles and Shared Mobility. State of the Research Topical Paper #5: Prioritizing Equity, Accessibility and Inclusion around the deployment of Automated Vehicles. https://onlinepubs.trb.org/onlinepubs/AVSMForum/products/5-NCHRP_Paper_Equity_Final_10-28-20v2.pdf

[10]Cohen, S. Transform, Shirazi, S.,California Governor's Office of Planning and Research. (2017, February). Policy Brief: Can We Advance Social Equity with Shared, Autonomous and Electric Vehicles. UC Davis Institute of Transportation Studies.https://3rev.sf.ucdavis.edu/sites/g/files/dgvnsk6431/files/files/page/3R.Equity.Indesign.Final_.pdf

addition, by building early public private partnerships based on accessibility and affordability, industry and the private sector can work by design to create equitable systems.

04
Food Insecurity

Autonomous vehicles have the potential to significantly counter access related food insecurity. Food insecurity is a measure of the level of access underserved communities have to healthy food. Although the term food deserts has been used to describe the isolation of certain communities that are more than 1 mile away from a grocery store, scholarship has evolved to include more textured analysis of how communities access food.[11, 12] Food insecurity includes factors such as affordability, grocery store proximity to where people work, and other factors that paint a more complete picture of access.

A Nuro vehicle delivers groceries

Currently, one in five Black people live in a food desert.[13] Research commissioned by the U.S. Department of Agriculture found that in most areas, the higher the concentration of minorities, the more likely an area will be a food desert.[14] The same study cites access to transportation as a key element of access. A grocery store not in

[11]Dutko, no. 8.

[12]Nargi, L. (2021). Critics say it's time to stop using the term "food deserts". The Counter. https://thecounter.org/critics-say-its-time-to-stop-using-the-term-food-deserts-food-insecurity/amp/

[13]Chui, M., Gregg, B., Kohli, S., Stewart III, S. (2021, August 6). A $300 Billion Opportunity: Serving the Emerginig Black American Consumer. McKinsey Quarterly. https://www.mckinsey.com/featured-insights/diversity-and-inclusion/a-300-billion-dollar-opportunity-serving-the-emerging-black-american-consumer

[14]Dutko, P., VerPloeg, M., Farrigan, T., (2012, August). Characteristics and Influential Factors of Food Deserts. USDA. Economic Research Service. Economic Research Report Number 140. https://www.ers.usda.gov/webdocs/publications/45014/30940_err140.pdf

walking distance becomes accessible if a community has access to AV systems. In addition, grocery delivery services are expected to expand with the use of AVs.

Food delivery services have already begun to transform the way underserved communities are accessing food.[15] The U.S. Department of Agriculture has significantly expanded access to food delivery services by making online food delivery services accessible to Supplemental Nutrition Assistance Program (SNAP) beneficiaries. Forty-two million people access SNAP benefits every month.[16] The low-income households accessing SNAP benefits are disproportionately residents of food deserts.

Nuro, an AV company, has made strides in developing systems to counter food insecurity.[17] The company estimates that AV deliveries within 30 minutes of all major supermarkets are capable of reaching 70 percent of all residents of food desert locations. Nuro has been operating successfully in Houston's Third Ward, a historically African American community. In order to reduce delivery costs to customers, Nuro is building smaller AVs specifically designed for grocery delivery. These AVs will be packed with groceries and deployed to customer homes.

05
Transportation Safety

Future AV based transportation will have a significant impact on reducing traffic accidents. When fully deployed, AVs will be able to sense and avoid both vehicles and pedestrians. In addition, AVs will not suffer from diminished operating safety due to driver impairment, low light, or bad weather. AVs will also travel at controlled speeds

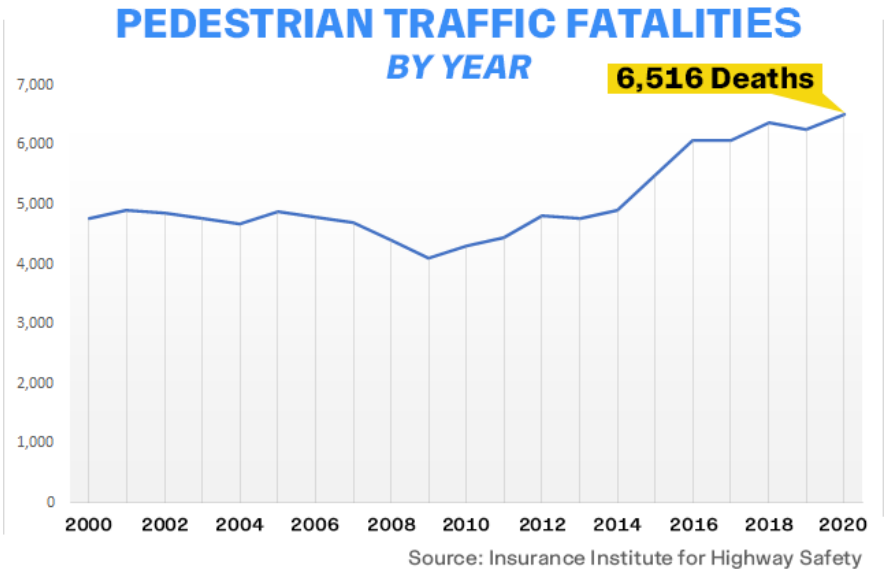
[15]SNAP Online Purchasing Pilot. USDA Food and Nutrition Service. https://www.fns.usda.gov/snap/online-purchasing-pilot

[16]Supplemental Nutrition Assistance Program Participation and Costs: Data as of May 3, 2022. USDA Food and Nutrition Service. https://fns-prod.azureedge.us/sites/default/files/resource-files/SNAPsummary-5.pdf

[17]Lawal, S. (2020, July 15). Serving America's Food Deserts. Medium. https://medium.com/nuro/serving-americas-food-deserts-a7442e922053

and will not exceed speed limits, a significant cause of many automobile related fatalities. In 2020, 38,680 people died in automobile accidents, including 6,236 pedestrians.[18]

Transportation safety disparities impact the lives of millions of Americans. Minority communities suffer significant disparities in injury and death, including as pedestrians, drivers and passengers. Native Americans are nearly three times as likely to die in a traffic fatality as white Americans.[19] African Americans are 20 percent more likely to die in traffic accidents than white Americans.[20] Traffic deaths are the leading cause of death among Hispanics under the age of 34.[21] Minorities are also disproportionate victims of impaired drivers.[22] Traffic fatalities among African Americans in 2020 increased 23 percent.[23]



Autonomous vehicle systems will provide significant advances in traffic safety. Waymo, an industry leader in providing publicly available AV safety information, logged over 15 billion automated vehicle miles in simulation and over 20 million

[18]U.S. Department of Transportation. (2022, January). National Roadway Safety Strategy. https://www.transportation.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf

[19]Retting, R. (2021, June). An Analysis of Traffic Fatalities by Race and Ethnicity. Governors Highway Safety Association. https://www.ghsa.org/sites/default/files/2021-06/An%20Analysis%20of%20Traffic%20Fatalities%20by%20Race%20and%20Ethnicity.pdf

[20]Ibid.

[21]Henk, R. (2012, March). High Crash Rates among Hispanics and Military Prompt Study. Texas Transportation Researcher. Volume 48, Number 1. https://tti.tamu.edu/researcher/high-crash-rates-among-hispanics-and-military-prompt-study/

[22]Ibid.

[23]U.S. Department of Transportation, NHTSA. (2022,March 2). NHTSA releases 2020 Traffic Crash Data. NHTSA. https://www.nhtsa.gov/press-releases/2020-traffic-crash-data-fatalities

real world miles on roads.[24] A study of Waymo's Phoenix, Arizona operations, based on 6.1 million miles driven, both simulated and real, revealed 47 collisions.[25] These collisions were classified as low severity and the overwhelming majority were caused by other drivers. To put this number in rough context, Waymo's 6.1 million vehicle miles and 47 low severity incidents compares favorably to 2020's US transportation statistics: 2.9 billion miles driven and 38,680 deaths. Although researchers are hesitant to draw conclusions based on the many different variables involved, AV research is beginning to develop solid data for ensuring safety.

According to Transportation Secretary Pete Buttigieg, "The rising fatalities on our roadways are a national crisis; we cannot and must not accept these deaths as inevitable."[26] The Transportation Department's National Roadway Safety Strategy includes a Safer Vehicles Initiative that promotes the deployment of AV technologies such as sensors and braking systems for pedestrian avoidance.[27] Level 5 AVs will provide significantly expanded protections for drivers and pedestrians.

06
Workforce Transportation

Equitable mobility access is essential to providing equal access to jobs. According to Census data, Black commuters have consistently had the longest commutes of any racial or ethnic group.[28] Commute times have significant impacts on education, community engagement, and health. Moreover, e-commerce jobs represent significant

[24]Waymo Safety (2022). https://waymo.com/safety/

[25]Schwall, M., Daniel, T., Victor, T., Favoro, F., Hohnhold, H. (2020). Waymo Public Road Safety Performance Data. Waymo LLC. https://storage.googleapis.com/sdc-prod/v1/safety-report/Waymo-Public-Road-Safety-Performance-Data.pdf

[26]USDOT-NHTSA Release, note 18.

[27]USDOT, note 14.

[28]Brasuell, J. (2022, April 22). The Disparate Racial Impacts of Commute Times. Planetizen. https://www.planetizen.com/news/2022/04/116930-disparate-racial-impacts-commute-times

economic growth in the US economy.[29] Between September 2017 and September 2021, 1.4 million tech e-commerce jobs were created.[30] In addition, the e-commerce sector has added significantly more jobs than have been lost in the retail sector (2007 to 2016- 355,000 jobs in e-commerce gained versus 51,000 retail jobs lost).[31] These jobs pay better wages and provide more benefits.[32]

Unfortunately, many of these jobs are not accessible to those without cars. According to a study by Securing America's Future Energy (SAFE), Amazon's 60 largest fulfillment centers and facilities are all inaccessible by public transportation and require a car.[33] According to a Brookings Institute study, between 2000 and 2012, jobs within a typical commute distance of hispanic workers dropped 17 percent.[34] Jobs within a typical commute dropped 14 percent for Black workers while only dropping 6 percent for white workers. This study also found that 55 percent of majority-minority communities suffered drops in job proximity.

Job proximity issues are further exacerbated by minority communities' disproportionate reliance on public transportation. In urban areas, for example, Blacks and Hispanics are more than twice as likely to rely on public transit than white residents.[35] As a result, many jobs beyond the reach of public transit become inaccessible to significant portions of minority communities. In addition, these communities are acutely impacted by cuts to public transportation services. These cuts can drastically increase commuter costs or completely eliminate job access.

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[29]Mandel, M. (2021, October18). Tech-Ecommerce Drives Job Growth in Most States. Progressive Policy Institute. https://www.progressivepolicy.org/blogs/tech-ecommerce-drives-job-growth-in-most-states/

[30]Ibid.

[31]Mandel, M. (2017, March). The Creation of a New Middle Class: A Historical and Analytical Perspective on Job and Wage Growth in the Digital Sector, Part 1. Progressive Policy Institute. httphttp://www.progressivepolicy.org/wp-content/uploads/2017/03/Tech-middle-class-3-9-17b.pdf

[32]Ibid.

[33]Feen, G., Bin-Nun, A., Panasci, A. (2020, July). Fostering Economic Opportunity through Autonomous Vehicle Technology. SAFE (Securing America's Future Energy). https://2uj256fs8px404p3p2l7nvkd-wpengine.netdna-ssl.com/wp-content/uploads/2020/07/Fostering-Economic-Opportunity-through-Autonomous-Vehicle-Technology.pdf

[34]Kneebone, E., Holmes, N. (2015, March). The growing distance between people and jobs in metropolitan America. Brookings. https://www.brookings.edu/wp-content/uploads/2016/07/Srvy_JobsProximity.pdf

[35]Anderson, M. (2016, April 7). Who relies on public transit in the U.S.? Pew Research Center. https://www.pewresearch.org/fact-tank/2016/04/07/who-relies-on-public-transit-in-the-u-s/

The deployment of AVs will provide expanded access to job markets that are currently not accessible. AV systems, if properly deployed, will enable transportation insecure workers to access and be retained at jobs that are currently too difficult to reach. With most mass transit systems cutting routes and struggling to maintain service hours, an AV system that complements existing transportation networks by closing gaps should provide significant growth in accessible job markets. A study of the Washington, DC Metropolitan area estimates that when autonomous vehicle systems are combined with public transportation, accessibility will increase by over 150 percent.[36]

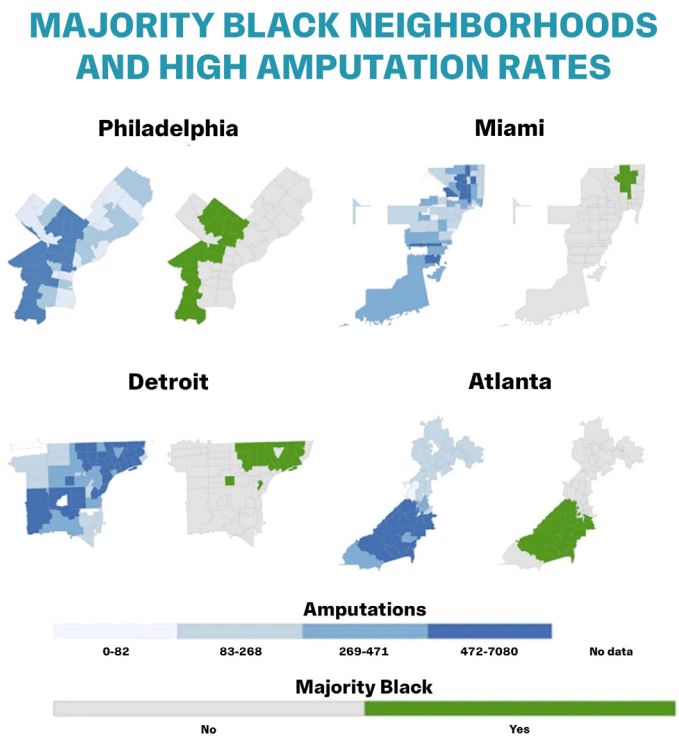
07
Healthcare Access

Underserved communities have long faced reduced access to healthcare due to the same geographic isolation impacts that create other forms of transportation and food insecurity. Autonomous vehicles can play a significant role in addressing these disparities.

Access to specialty care is heavily influenced by distance to specialty care services. Considering the vast racial disparities in many areas of health, mortality, and disease among underserved populations, few issues are as stark in terms of life and death consequences. Moreover, few solutions can make as much of an impact as an AV system providing the accessible, reliable and affordable medical transportation that does not currently exist in our healthcare system.

[36]Cohn, J., Ezike, R., Martin, J. (2019, March 19). *Examining the Equity Impacts of Autonomous Vehicles: A Travel Demand Model Approach*. Transportation Research Record: Journal of Transportation Research Board. As cited in Dianin, A., Ravazzoli, E., Hauger, G. (2021, April 16). *Implications of Autonomous Vehicles for Accessibility and Transport Equity: A Framework Based on Literature*.

Wound care is an example of disparate access to treatment.[37, 38] For example, proper treatment of diabetic foot care issues requires the support of specialty doctors such as podiatrists, orthopedic, and vascular surgeons and endocrinologists. Black people are more than 3 times more likely to need amputations to treat diabetic foot care issues than any other race or ethnic group.[39] Unfortunately, the patients most in need of these specialty doctors are likely to have limited mobility that would prevent difficult and frequent commutes to doctors' offices. A vibrant AV system would greatly improve the options available to diabetic foot care patients by providing easily accessible and affordable rides to medical practices.



Source: Geographic and Socioeconomic Disparities in Major Lower Extremity Amputation Rates in Metropolitan Areas

A study conducted in Philadelphia found that census tracts with a high percentage of African American residents were 28 percent more likely to have low access to primary healthcare.[40] Low access is defined as having a significantly low number of primary care physicians relative to the population of the census tract. Since many of these

[37]Armstrong, D. (2022, January 29). Geographic and Socioeconomic Disparities in major lower extremity amputation rates in Metropolitan areas. Diabetic Foot Online. https://diabeticfootonline.com/2022/01/29/geographic-and-socioeconomic-disparities-in-major-lower-extremity-amputation-rates-in-metropolitan-areas-actagainstamputation-alpslimb/

[38]Leonard, K. (2014, October 14). Amputation more likely for Blacks. US News & World Report. https://www.usnews.com/news/blogs/data-mine/2014/10/14/blacks-with-diabetes-more-likely-to-face-amputation?-context=amp

[39]Ibid.

[40]Brown, E., Polsky, D., Barby, C., Seymour, J., Grande, P. (2016, August). Racial Disparities in Geographic Access to Primary Care in Philadelphia. Health Affairs. https://www.healthaffairs.org/doi/10.1377/hlthaff.2015.1612

neighborhoods lack physicians within close proximity, many within these communities are forced to rely on rides or public transportation.

A National Institute of Health review of studies on transportation barriers in healthcare unveiled multiple examples of the difficulties many face in accessing healthcare when they are transportation insecure.[41] In one study, 55 percent of African American cancer patients and 60 percent of Hispanic cancer patients cited lack of access to a ride as the reason for missing cancer treatments.[42] Another study found that those living in households without cars are significantly less likely to begin chemotherapy.[43] And, another found that 21 percent of urban youth have experienced transportation barriers due to the expense, distance or difficulty of accessing medical care through public transportation.[44]

AV transportation systems would make health practices more accessible to individuals and communities currently unable to readily access these practices due to proximity issues and a lack of access to transportation. The inability to access comfortable and reliable transportation is a major barrier to healthcare access for many diverse communities.[45] A robust AV system will transport patients and caregivers and even the playing field for those without cars or reliable public transportation. Patients avoid beginning chemotherapy due to the lack of access to transportation. A significant amount of children are not receiving care due to transportation barriers. And, other specialty care needs such as diabetic foot care consistently expose disparities that are at least in part caused by transportation barriers. **Public health stakeholders should engage AV deliberations to help fashion solutions that eliminate transportation barriers for those seeking healthcare.**

[41]Syed, S., Gerber, B., Sharp, L. (2014, December 13). Traveling Towards Disease: Transportation Barriers to Healthcare Access. National Library of Medicine. J. Community Health. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4265215/

[42]Ibid.

[43]Ibid.

[44]Ibid.

[45]Ibid.

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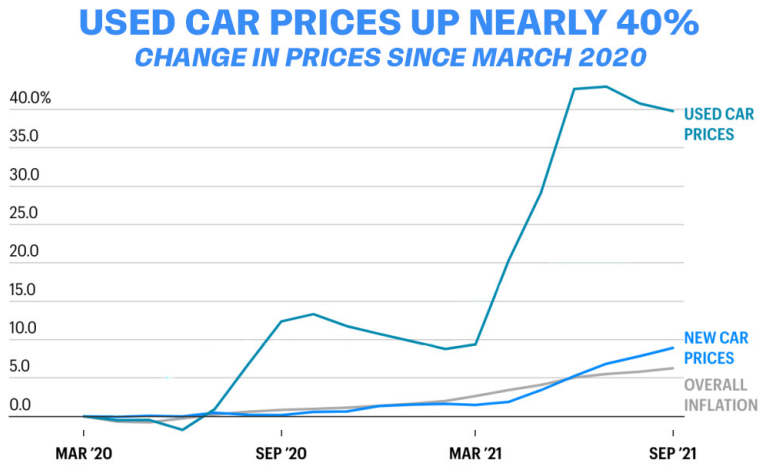
08 Potential Implications

Affordability - An AV system that is affordable will have a very different equity impact than a system that is not affordable. The economics of affordability depend on a number of significant factors. Business model inputs including public subsidies, speed to scale, geographic access, regulatory requirements, insurance, liability and technology advances will all affect the degree to which and how soon AV systems become affordable and accessible for all.



SOURCE: U.S. BUREAU OF LABORBUREAU OF LABOR STATISTICS, FORTUNE

A robust AV environment will enable a new approach to affordable and reliable transportation in contrast with the challenges now confronted by the transportation insecure. The cost of cars has risen significantly.[46] Used car prices have increased 40.5 percent in one year. New car prices have also increased significantly. Insurance costs and disparities in coverage and pricing add additional difficulty to the underserved. Moreover, parking often incurs garage costs. The cost to operate individual vehicles is a growing economic burden which many in underserved communities cannot sustain. Some models of AV systems have eventual AV transportation costs competitive with public transit rates. SAFE estimates that AVs will reduce costs by $5,600 per house per year.[47] Diverse community benefits will correlate directly with the affordability of AV systems.

[46]Shen, M. (2022, February 13). Used Cars cost 40.5% more than last year as gas prices rise. New car prices also climbing. USA Today. https://www.usatoday.com/story/money/cars/2022/02/13/used-cars-cost-more/6778705001/

[47]Feen, note 24.

Future of Work Considerations - Despite previous predictions of significant net job losses from the future deployment of AVs, the future impact of AVs on jobs is unclear.[48, 49] AV deployment is likely to create significant new jobs in remote assistance, fleet manufacturing, fleet maintenance, and in other positions likely to be created as businesses and governments begin leveraging the new technology. In order to prepare for new positions in a transformed system, AV companies, governments, and nonprofits must work together to provide training and community engagement to ensure full underserved participation in the AV economy.

09
Conclusion

The design and deployment of autonomous vehicle systems presents a rare opportunity to make significant progress in addressing seemingly insurmountable challenges in addressing many different disparate impacts. AV technology should be utilized as a tool to address health disparities, food insecurities, traffic safety, job access and other social ills lingering as a result of systemic discrimination. AVs are not capable of solving every problem but they are capable of significantly leveling the playing field in many areas. These advances will only be achieved if intentionality is built into every phase of AV design and deployment. Affordability is accessibility. Sustainable business models are just as important as the technology. All parties must do their part to usher in a successful system where all communities share in the benefits of AV equity.

[48]Coppola, G. (2021, August 10). Driverless Cars Are Proving to Be Job Creators, At Least So Far. Bloomberg. https://www.bloomberg.com/news/newsletters/2021-08-10/driverless-cars-are-proving-to-be-job-creators-at-least-so-far

[49]Austin, A., Buknor, C., Cashman, K., Rockeymoore, M. (2017). Autonomous Vehicles, Driving Jobs, and the Future of Work. Stick Shift. Center for Global Policy Solutions. https://globalpolicysolutions.org/wp-content/uploads/2017/03/Stick-Shift-Autonomous-Vehicles.pdf