Undergraduate Thesis Prospectus

# Connecting Motorists to Real-time Weather

(technical research project in Aerospace Engineering)

# Free Parking or Livable Cities? An Urban Planning Controversy

(sociotechnical research project)

by

Allen Lang

May 9, 2021

technical project collaborators:

Arianna Asquini, Mici Cummings, Ian Davis, Kyle Ebanks, Rikia Freeman, Raeann Giannattasio, Pranav Sridhar, Elias Topp, Ethan Vicario, Avery Walker

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.
*Allen Lang*

*Technical advisor*: Christopher Goyne, Department of Mechanical and Aerospace Engineering

*STS advisor*: Peter Norton, Department of Engineering and Society

## General Research Problem

*How can American surface transportation systems be improved in terms of efficiency and sustainability?*

U.S. surface transportation systems have not kept pace with economic growth. To some transportation interest groups, the problem is attributable to insufficient public spending on transportation infrastructure (ASCE, 2017; ARTBA, 2019); to others it is due to misdirected public spending that prioritizes the least cost-effective transportation modes to the detriment of fiscally and environmentally sustainable modes (Marohn, 2019; NACTO, 2020; Streetsblog, n.d.). In 2017, the American Society of Civil Engineers' Committee on America's Infrastructure gave abysmal grades to transportation, recommending improvements in efficiency and sustainability (ASCE, 2017). Efficient transportation systems nurture efficient economies by streamlining the flow of goods and services. The price of inefficiency is steep. Bridge inspector Jeff Madsen estimated that closing the deteriorating, 80-year-old Chester Bridge would force drivers into a 4-hour detour (VICE News, 2020). Chester Bridge is just one of the 47,000 bridges across the country that are structurally deficient (FHWA, 2019). A good transportation system is also safe, and environmentally and fiscally sustainable. After steady drops in fatality rates per vehicle miles traveled from 1975 to 2010, the metric has remained constant over the past five years (NHTSA, 2020). About 28 percent of total U.S. greenhouse emissions are attributable to transport (EPA, 2020). While some interest groups assert that expanding road capacity may reduce total vehicle emissions by reducing delay (ASCE, 2017), the research consensus clearly contradicts this claim (Duranton and Turner, 2009). While most agree that a good surface transportation system is efficient, sustainable, and safe, experts, interest groups, and advocacies disagree about how these values are best pursued.

**Connecting Motorists to Real-time Weather**

*How can drivers be informed en route of the weather information necessary for safe and efficient driving?*

As one of the country's largest state-maintained highway systems, Virginia's roads plays an important role in economic growth (VDOT, 2019). However, Virginia suffers from debilitating congestion, with three of the nation's fifty worst bottlenecks coming from Northern Virginia alone (Forzato, 2015). One reason is adverse weather. Precipitation makes hazardous conditions that force slowdowns: differing intensities reduce speeds by 3% to 40%. From 2007 to 2016, weather was responsible for 21% of all vehicle crashes in the US (FHWA, 2020). For a state like Virginia, whose motorists waste $9.5 billion annually in time and fuel sitting in traffic, alleviating weather's effect on traffic can improve quality of life and boost productivity (TRIP, 2020).

From the MAE Department, Professor Goyne will supervise this capstone team of eleven students. The project goal is to refine channels between weather data and users so that accidents and congestion can be lessened. Fulfillment of this requires understanding of weather data collection, proliferation, and influence.

Virginia's weather information is a synthesis of data from space and ground sources. In space, the most prominently used satellites are from the National Oceanic and Atmospheric Administration's (NOAA) GOES system. These satellites carry an Imager that measures incoming infrared radiation from the Sun, and a Sounder that observes atmospheric profiles and cloud coverages. The current generation, GOES-16, offers greater imagery and resolution with increased frequency, providing weather updates every 30 seconds (NWS, n.d.). Surface based instruments like Doppler radar, ground stations, and weather buoys supplement satellites in addition to collecting data hard to obtain from space like precipitation intensity. Finally, human

observations are submitted to NOAA's National Center for Environmental Information (NCEI) as an additional verification method (NOAA, n.d.).

Contemporary navigational information is delivered to drivers assuming clear weather conditions. Two companies solve this by incorporating real-time weather in their navigation products. Vaisala is a Finnish company that offers industrial weather measurement devices and data services. Its in-car software product, Vaisala Infotainment, informs drivers of hazardous conditions and formulates routes based on current weather (Vaisala, n.d.). Weather Telematics is a solutions company that works with GPS fleet tracking services. Machine learning models advise drivers about weather and calculate mid-route alterations. Its company goals are to provide a "suite of map-based media tools help travelers choose the safest route - avoiding delays while at the same time reducing congestion, fuel consumption, operating costs and above all, avoiding high-risk accident zones" (Weather Telematics, n.d.). While both are effective, the solutions are proprietary and commercial-based, unavailable for most motorists.

Research has attempted to gauge how drivers use weather data to drive safely. The few studies done have relied on a phone survey to measure this human factor. In response to two winter storms in Utah, drivers, on average, looked at two to three weather sources before commuting. Most of the sources came from local weather stations and personal connections rather than government websites like NOAA. When asked about the available weather data, almost all drivers felt satisfied with its quality. Despite being well-informed, the majority of drivers answered that the actual storm was more severe than they expected. Additionally, only a small portion of the drivers adjusted their behaviors (Barjenbrunch et al., 2016). Any effective solution will need to account for human sentiment.

To accomplish the project goal, the group will build upon the literature review by engaging with experts and exploring the feasibility of satellite communication with users on cellular devices. The final product will be a theoretical solution that will offer insight into a realistic implementation that informs drivers of adverse weather conditions and creating safer and less congested roads.

**Reintegration over Expansion: Activism against Free Parking**

*In the U.S., how are critics of local zoning ordinances that subsidize driving advancing their agendas?*

Beginning in the 1930s, many local governments mandated parking minimums in response to increased automobile use. To comply with such ordinances, real estate developers have had to provide parking spaces; requirements vary by land use. The spaces are valuable but motorists often pay nothing for them; such charge-free parking is often called “free parking”. For example, Washington D.C. requires “libraries constructed after December 19, 2003 and in excess of 2,000 square feet of gross floor area, 1 space for each additional 1,000 square feet of gross floor area” (DC Office of Zoning, 1958). Minimums are intended to ensure businesses and other land uses have sufficient peaking at peak demand hours; at other times many lots may be mostly empty. Critics contend such large lots are wasted space that could be better used for other purposes.

New urbanists typically oppose parking mandates, favoring instead more environmentally friendly urban design that accommodates walking, cycling, transit, and shared public spaces. They are critics of the urban planning norms that prevailed after World War II, including those favoring automobile-dependent design and low-density suburbs. New urbanist designs prioritize people over cars, reintegrating residential and commercial developments separated by suburbia

(Fulton, n.d.). Reducing the importance of cars means reductions in free parking. When Steve Jobs unveiled Apple Park, he stressed the idea of natural landscaping, placing parking underground so that the surface could be walkable and hospitable for its 12,000 employees. He lamented the inclusion of another parking lot above ground: "that's [underground garage] not enough [to satisfy city mandatory minimums], unfortunately" (Cupertino City Council, 2011).

Some nonprofit advocacies oppose parking mandates. Strong Towns, founded by Charles Marohn, advocates for fiscal sustainability and local autonomy in planning through podcasts, seminars, courses, and community boards. A Sioux Falls resident, Jordan Diffenbaugh, credits Marohn's visit to the town for inspiring him to form a local affiliate. According to Diffenbaugh, Marohn supports modest city planning, eschewing "big projects that don't go anywhere" for smaller and more cost-effective initiatives (Severin, 2019). To Marohn, ambitious horizontal expansion overstretches a city's resources. Free parking has thus become a target: "these rules are not only unnecessary: they are destructive of our communities' financial strength and resilience" (Strong Towns, n.d.).

Incremental Development Alliance (IDA) shares Strong Towns' small-scale approach, advising small towns through its network of engineers and urban designers. IDA calls for "neighborhood-based small developers creating buildings that can adapt to times of trouble" (IDA, n.d.). It opposes parking mandates. To cofounder Monte Anderson, they prevent repurposing abandoned properties: "without adjustments to parking requirements, there are businesses that cannot be used" (Marohn, 2017).

Donald Shoup is an important influence among organized and unorganized critics of parking mandates. Shoup, an urban planning professor at UCLA, is best known for his book *The High Cost of Free Parking* (2005), a case for market-priced parking. Shoup claims that free

parking laws “increase traffic, congestion, air pollution, and energy consumption” (Vanderbilt, 2015). He contends that mandatory minimums subsidize driving. Shoup favors parking priced dynamically, in response to demand; since 2005, Shoup-inspired parking programs have emerged across the country. SFpark is San Francisco’s version: variable-price parking meters with sensors detect occupancy rates (Shoup, 2005).

Staunch supporters of free parking remain, among them the opponents of SFpark who have kept it out of their neighborhoods. They contend that the parking charges are burdensome to residents who rely on cars, and that free parking is essential for family and commercial life. Eastern Neighborhoods United Front (ENUF) has attacked SFpark, likening its methods to those of the disgraced company Enron (Bialick, 2012). Save Polk Street has protested policies that displace curb parking to improve conditions for cyclists. A member, Chris Provan, has blamed bike lanes for hurting his business, and fears that removal of free parking would exacerbate the damage (Bialick, 2013).

Research have studied parking mandates and the competing values that divide their defenders from their critics. Shoup (1999) has argued that by surveying demand at free parking sites, engineers inflated estimates of total parking demand. Lewyn (2010) found that abundant parking subsidizes driving and thereby increases it. Hasker and Inci (2014) defend free parking at shopping malls because consumers who park free of charge will pay more for retail goods. New urbanism is controversial; some argue that it cannot apply its own principles. For example, Grant (2006) observes that while new urbanists say they favor the public sphere over the private, their designs in practice have been gentrified and exclusive.

## References


ASCE (2017). American Society of Civil Engineers. 2017 Infrastructure Report Card. https://www.infrastructurereportcard.org/wp-content/uploads/2019/02/Full-2017-Report-Card-FINAL.pdf

ARTBA (2019). American Road & Transportation Builders Association. 47,000 U.S. Bridges in Poor Condition & Pace of Repair Slows to Crawl, New Analysis of Federal Data Shows. https://www.artba.org/2019/04/01/47000-u-s-bridges-in-poor-condition-pace-of-repair-slows-to-crawl-new-analysis-of-federal-data-shows/

Barjenbruch, K., Werner, C. M., Graham, R., Oppermann, C., Blackwelder, G., Williams, J., Merill, G., Jensen, S., Connolly, J. (2016). Drivers' Awareness of and Response to Two Significant Winter Storms Impacting a Metropolitan Area in the Intermountain West: Implications for Traffic Flow in Inclement Weather. *Weather, Climate, and Society, 8*(4), 475-491. JSTOR.

Bialick, A. (2012). SFMTA abandons SFPark expansion in favor of conventional meters. StreetsBlogSF. https://sf.streetsblog.org/2012/04/04/sfmta-abandons-sfpark-expansion-in-favor-of-conventional-meters/

Bialick, A. (2013). Debunking the Misinformation Propagated by "Save Polk Street." StreetsBlogSF. https://sf.streetsblog.org/2013/05/03/debunking-the-misinformation-propagated-by-save-polk-street/

City of Cupertino (2011, June 7). Steve Jobs Presents to the Cupertino City Council (6/7/11) [Video]. YouTube. https://www.youtube.com/watch?v=gtuz5OmOh_M

Duranton, G., Turner M. (2009). The fundamental law of road congestion: Evidence from US cities. *American Economic Review, 101*(6), 2616-2652. AER.

EPA (2020). Environmental Protection Agency. Inventory of U.S. Greenhouse Gas Emission and Sinks. https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf

FHWA (2019). Federal Highway Administration. Bridge Condition by Highway System 2019. https://www.fhwa.dot.gov/bridge/nbi/no10/condition19.cfm

FHWA (2020). Federal Highway Administration. How Do Weather Events Impact Roads? Road Weather Management Program. https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm

Forzato, J. (2015). Three of nation's worst bottlenecks in Northern Virginia, study finds. WTOP News. https://wtop.com/dc-transit/2015/11/study-three-nations-worst-bottlenecks-northern-virginia/

Fulton, W. (n.d.). The New Urbanism Challenges Conventional Planning. Lincoln Institute of Land Policy. https://www.lincolninst.edu/publications/articles/new-urbanism-challenges-conventional-planning

Grant, J. (2006). The Ironies of New Urbanism. *Canadian Journal of Urban Research, 15*(2), 158-174. JSTOR

Hasker, K. & Inci, E (2014). Free parking for all in shopping malls. *International Economic Review, 55*(4), 1281-1304. JSTOR.

IDA (n.d.). Incremental Development Alliance. Our Philosophy. https://www.incrementaldevelopment.org/philosophy

Lewyn, M. (2010). What would Coase do? *Fordham Environmental Review, 22*(1), 89-118. JSTOR.

Marohn, C. (Host). (2017, Nov. 21). How parking minimums hinder small-scale developers (No. 459). [Audio podcast episode]. In Strong Towns Podcast. Shout Engine. https://shoutengine.com/StrongTownsPodcast/how-parking-minimums-hinder-small-scale-developers-46986

Marohn, C. (2019). *Strong Towns: A Bottom-Up Revolution to Rebuild American Prosperity*. Wiley.

NACTO (2020). National Association of City Transportation Officials. NACTO 2020 Policy Platform. https://nacto.org/wp-content/uploads/2020/03/2020NACTOPolicyPlatform.pdf

NHSTA (2020). National Highway Traffic Safety Administration. Preview of Motor Vehicle Traffic Fatalities in 2019. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813021

NOAA (n.d.). National Oceanic and Atmospheric Administration. Weather observations. https://www.noaa.gov/education/resource-collections/weather-atmosphere/weather-observations

NWS (n.d.). National Weather Service. Satellites. https://www.weather.gov/about/satellites

DC Office of Zoning (1958). District of Columbia Office of Zoning. Section 11-2101. Schedule of requirements for parking spaces. Elaws. http://dcrules.elaws.us/dcmr/11-2101

Severin, J. (Host). (2019, May 8). Strong Towns (No. 11). [Audio podcast episode]. In Making a Living Podcast. WETA. https://watch.weta.org/video/strong-towns-zfahyp/

Shoup, D. (1999). The trouble with minimum parking requirements. *Transportation Research, 33*(7), 549-574. http://shoup.bol.ucla.edu/Trouble.pdf.

Shoup, D. (2005). *The High Cost of Free Parking*. American Planning Association.

Streetsblog (n.d.). About. https://www.streetsblog.org/about/

Strong Towns (n.d.). Parking Minimums. Strong Towns. https://www.strongtowns.org/parking

TRIP (2020). Virginia Transportation by the Numbers – February 2020. TRIP. https://tripnet.org/reports/virginia-transportation-by-the-numbers-trip-report-february-2020/

Vaisala (n.d.). Weather & Road Weather Data for Automotive. Vaisala Digital. https://www.vaisala.com/en/digital-and-data-services/automotive

Vanderbilt, T. (2015). There's no such thing as free parking. *Slate*. https://slate.com/news-and-politics/2015/09/nimble-cities-can-eliminating-parking-spots-make-cities-more-efficient.html

VDOT (2019). Virginia Department of Transportation. Virginia's Highway System. http://virginiadot.org/about/vdot_hgwy_sys.asp

VICE News (2020, February 17). America's Infrastructure Is Crumbling [Video]. YouTube. https://www.youtube.com/watch?v=EdvJSGc14xA

Weather Telematics (n.d.). Industries. http://www.weathertelematics.com/page/industries