Cheryl Deutsch
3867 College Ave #3
Culver City, CA 90232
cheryl.deutsch@gmail.com

How the Lines Get Drawn: Social Science Research in the Origins of Metropolitan Transportation Planning

Abstract

Metropolitan transportation planning came of age in response to traffic congestion and urban decline of the 1950s. Engineers within the emerging field planned urban highways to pave the way for economic growth in American cities. Today, we know the costs and benefits of such development choices, and an interdisciplinary field of mobility studies has emerged to analyze "the system of automobility," among other forms of mobility (Urry, 2004). Using archival research of transportation studies and social science scholarship of the mid-20th century, as well as interviews with transportation planners of the era, this paper seeks to highlight the role of the social sciences in the development of metropolitan transportation planning methods. I find that current methods of transportation planning - including the use of travel demand forecasts - are the spin-off of a previous era of mobilities research within sociology and the social sciences more broadly.

Article

Metropolitan transportation planning came of age in response to traffic congestion and urban decline of the 1950s. Engineers within the emerging field planned urban highways to pave the way for economic growth in American cities. Today, we know the costs and benefits of such development choices, and an interdisciplinary field of mobility studies has emerged to analyze "the system of automobility," among other forms of mobility (Urry, 2004). Using archival research of transportation studies and social science scholarship of the mid-20th century, as well as interviews with transportation planners of the era, this paper seeks to highlight the role of the social sciences in the development of metropolitan transportation planning methods. I find that current methods of transportation planning - including the use of travel demand forecasts - are the spin-off of a previous era of mobilities research within sociology and the social sciences more broadly.

The New Mobilities Paradigm

A new mobilities paradigm has emerged across various fields of the social sciences over the last two decades (Sheller 2011; Sheller & Urry, 2006). Bringing together sociologists, geographers, and anthropologists, the new paradigm explores themes of migration, transportation, and mobile technologies and offers to counter the

sedentarism of urban studies (Creswell, 2003) by asserting roads (Dalakoglou 2010, 2012; Laurier 2004; Merriman 2009), cars (Dant 2004, Laurier 2011), motorbikes (Truitt 2008), metros (Butcher 2011, Sadana 2010), and even airports (Adey 2004) as movement-space (Thrift 2003) worthy of social study. Others have studied the gendered (Jain 2002, Uteng & Cresswell 2008) and subaltern (Sheller 2011) dimensions of travel, arguing for a clearer articulation of the relationship between socio-economic mobility and physical or spatial mobility (Jain 2004). Many studies within the new mobilities paradigm have paid particular attention to car cultures and the role of automobility (Urry 2004) in shaping modern consumer subjectivities (Featherstone, et al 2005; Paterson 2007), forging national identities (Creswell 2006, Koshar 2004, Taussig 1991), and deepening social inequality (Lutz 2014). Some envision this new mobilities research playing a role in the future of city planning and transportation systems (Sheller 2011).

In this paper, I survey the history of methods in transportation planning, as they emerged in the middle of the last century. In doing so, I offer a more complex picture of the forces that drive the American transportation system than some of the new mobilities literature affords. My research reveals that transportation planning owes much to a previous era of mobilities scholarship in the social sciences; an era that the new mobilities research does not acknowledge. In a recent article, for example, the anthropologist Catherine Lutz argues that the culture of the automobile is responsible for inequality in the United States. Surveying the history and culture of our car dependence, she notes that the recent mobilities turn has subjected the car to a "sociological imagination" (2014, p.232). While the new mobilities research has contributed political economic analysis of cars and highways planning, in this paper, I argue that the recent mobilities turn is not the first time that transportation systems have been subjected to a sociological imagination.

The Urban Transportation Problem

The methods of urban transportation planning had to be invented. In the years following World War II, American cities were increasingly populous, sprawling, and auto-dependent. Traffic was *the* urban transportation problem that worried urban city leaders and inspired countless books and commentaries (see, for example Owen, 1956). Transportation planning emerged in those years as a professional marriage of highway engineering, city planning, and the social sciences, but the courtship of these fields was long and the outcome not always clear. Before what we today call planning - that is, systematic data collection and analysis of urban travel behavior, along with reasoned appraisal of multiple scenarios of infrastructure improvement - cities were shooting in the dark trying to solve the problems of urban traffic and downtown decline.

In its limited support for highway construction, the federal government didn't offer funding for research in highway construction until 1934. Ted Holmes, who later served as director of the Bureau of Public Roads (BPR, later the Federal Highway Administration), credited the 1934 Federal-Aid Highway Act and its support for highway research as the progenitor of transportation planning (1973). Even as early as 1944,

when the BPR published a framework for what would become the Interstate Highway System, the BPR called for highway planning to include comprehensive urban transportation planning based on research. Yet it was not until the 1950s that cities stakes an organized claim on highway funding in order to plan for city traffic.

Under the auspices of the American Municipal Association, they fought for the 1956 Federal-Aid Highway Act, which established the Interstate Highway System and the Highway Trust Fund to endow it. It was the 1956 Act that gave birth to urban highways, further entrenching racial segregation in many cities and contributing to downtown decline in their own way over time. The writer Tom Lewis has called the 1956 Act a Faustian bargain for cities (1997). If they did sell their souls in 1956, though, they did so under the banner of municipal reform and economic growth, as well as transportation planning. Urban mass transit systems, neglected during the war, suffered from financial hardship and competition from a growing number of cars on city streets. Mostly private at the time, transit systems were seen as inefficient and out of date as compared to private automobiles.

Downtown economies were experiencing decline as urban traffic mounted and suburban shops began to compete for downtown business. In this context, city leaders concluded that traffic congestion was a liability that fueled suburbanization and contributed to the decline of central cities. They blamed rural highways, especially, for contributing to urban traffic. Intended to bring farm produce to market, rural highways ended at the city limits, where they narrowed into city streets lined with shops and other businesses. City leaders concluded that these narrowing highways were dumping long-distance travelers onto the urban grid. Well-planned, controlled access highways through and around cities were the solution. By separating through traffic from city traffic, urban highways would reduce congestion on city streets and restore downtown economies. Civil engineering at the time had the benefit of decades of state and federal aid in building rural highways. Highway engineers were skilled in the construction of bridges, tunnels, and interchanges, as well as miles of open road paved with bituminous asphalt through even the roughest of terrain. Building highways through densely populated urban areas was another matter altogether, though (Rose & Mohl, 2012, p.x). To build urban highways, city leaders and engineers turned to city planners and sociologists to understand urban travel behavior.

The Old Mobilities Paradigm

It took time for urban transportation planning to develop as a behavioral study, rather than just an engineering problem. By the 1940s, “origin and destination” surveys were common in the country’s larger cities, where engineers counted cars and also stopped samples of drivers to ask them about the origins and destinations of their trips. They wanted to understand how many vehicles passed through the city on a daily basis and where people were making trips in the city. They also collected data from trucks, taxis, and transit agencies. An early study in Detroit began to connect trip-making to activities. There, engineers surveyed workers at large factories and firms about the origins of their work trips (Carroll, 1957).

It was home interview data that led engineers to sociology. Home interviews sent traffic engineers door-to-door to talk to people about the trips they had made the previous day. Kevin Heanue, now retired from a career in the BPR and later Federal Highway Administration, remembers conducting one hundred home interviews in Hartford, Connecticut as a young transportation engineer (personal communication, January 17, 2013). The experience of knocking on people's doors was invaluable, he says. One woman told him: "The only place I went yesterday was to the church and the cemetery to bury my sister." Another survey respondent was a truck driver who'd made forty trips the previous day. Where the home interview really improved on previous methods of studying origins and destinations was in its attention to the socio-economic motivations for travel, collecting data on car ownership, shopping and work habits, race, gender, family size, and employment. Tulsa, Oklahoma was the first city to use home interviews to collect origin and destination data (Bureau of Public Roads, 1954), and in 1944, the Bureau of Public Roads published a manual that made the new home interview technique widely available. By 1954, the BPR estimated that more than one hundred metropolitan areas had carried out origin and destination surveys based on home interviews (Bureau of Public Roads, 1954).

Even with home interview data, nobody had yet found a satisfactory formula to give numerical weight to the various qualitative factors involved in determining a traveler's trip route, for example. Read one report in 1950: "The analyst of origin and destination interviews is yet an explorer of uncharted areas in human behavior" (Campbell, 1950, p.i). A correspondence among state highway engineers in the late 1940s offers an example of the confounding behavioral aspects of urban travel that highway engineers were struggling to understand. One Arkansas engineer wrote about Little Rock: "We have within two blocks of the Capitol two parallel streets a block apart. One carries traffic at a point nearby of 15,000 vehicles per day and the other carries less than 5,000 vehicles per day. The less traveled street is wider and for the most part smoother but there are four blocks where there are old street car tracks and the distance of the four blocks is the only reason that I have been able to discover to cause motorists to use the more congested streets" (Campbell, 1950, p.46). Origin and destination data had revealed urban traffic to be varied, complex, and contextual. Even if the relevant variables motivating urban trips could be settled on and weighted so as to plan effective infrastructure improvements, surely they would need to be weighted differently for different populations, trip purposes, and modes of travel. A number of "intangible" variables also eluded mathematical formulation. Beauty, comfort, habit, safety, tension, "investigative desire," and "a desire for unremittent motion," were all such intangible variables that state highway engineers discussed in their efforts to address urban traffic problems (1950, p.i,7).

With the wealth of socio-economic, as well as travel data, that home interviews provided, origin and destination surveys saw an "invasion of the field" by sociologists, economists, and city planners (Oi & Shuldiner, 1962, p.7). The social studies of mobility from which they drew - exploring migration patterns, race relations, and consumer behavior - offered to unlock the complicated social code of urban trip-making. Using such social studies of mobility, those in the emerging field of transportation planning

developed statistical models of travel demand; models that continue to play an important role in transportation planning today.

In the 1940s and 50s, sociology and the broader social sciences were undergoing a technocratic turn. American sociologists were turning away from the discipline's classical focus on ideology as a driving force of social cohesion and change. Talcott Parsons, at the University of Chicago, led the cause of what would come to be known as functionalism, the idea that society can be studied as a system through its many interconnected - but coherent - parts (Sharrock, et al. 2003). It is an idea that still lingers in urban studies and governance practices today (Valverde, 2011). The functionalist view of society found a ready audience among highway engineers looking for "a more rational and scientific basis for the planning of an urban transportation system" (Oi & Shuldiner, 1962, p.7). Functionalism lent itself to quantitative methods, and although statistical analysis would predominate in sociology and urban studies over the next several decades, calls for the qualitative study of transportation systems and mobility did exist.

Margy Ellin Meyerson, for example, was a sociologist at Bryn Mawr College, who followed debates in traffic engineering and city planning. At a conference of highway engineers in 1955, she made a case for the study of transportation as a social phenomenon. The car in and of itself, she argued, is not alone responsible for suburbanization; rather, trends in decentralization and automobility must be understood in their social context and with an understanding of their sociological motivations. "Transportation decisions are not based on purely economic motivations," she argued (1955: 1). "We know relatively little about the shadings of meaning of car ownership, and how status strivings and aspirations are defined by different ethnic, age and geographic groups, and in addition how different personality attributes and ideological positions influence such attitudes. We also know relatively little about the status attached to various kinds of mass transportation facilities" (Meyerson, 1955, p.3-4). Meyerson's vision was, perhaps, ahead of her time. A number of studies sought to understand the car in its newly suburbanizing context, but they were more functionalist efforts to understand consumer behavior and lacked her interest in underlying meaning.

Postwar suburbanization, along with changing patterns of consumption, challenged the social and economic significance of downtown areas. Research in social science took a spatial turn. Interested in migration patterns, intercity travel, and the dissemination of news, for example, George Kingsley Zipf hypothesized that people and goods gravitated towards one another according to a uniform formula of movement: (P1*P2)/D, in which P1 and P2 represent two separate places and D the distance between them. He found that the amount of news reported about a city, P1, in the newspaper of a nearby city, P2, followed this formula, as did the movement of people by bus, rail, and air between 29 US cities using 1933-34 data (Zipf, 1946, p.681). Building on Zipf's work, Stuart Carter Dodd studied the pushes and pulls of social interaction and the forces of connection responsible for phenomena such as the spread of rumors through a community, choice of friends and spouses across geographic space, migration patterns, the reputation of a firm, "telephonic interactance," and commuting (Dodd, 1950, p.246-9).

In a similar attempt to model the formation and strength of retail markets across geographic space, William J. Reilly published a theory of retail competition in 1953. "Two cities attract retail trade … from an intermediate city … approximately in … proportion to the populations of the two cities and in the inverse proportion to the square of the distances from these two cities to the intermediate town," he wrote (quoted in Schmidt & Campbell, 1956, p.56). Because it mimicked Newton's Law of Gravity, the formula became known as "Reilly's Law of Retail Gravitation," and within two years, Harry J. Casey, Jr. (1955) adapted it to study shopping and work trips in urban transportation.

A number of studies attempted to quantify and measure the suburbanization of social phenomena. In an unpublished study for the Institute of Urban Land Use and Housing, for example, Peter H. Rossi analyzed "push" and "pull" factors in residential patterns to create an index of residential mobility (cited in Mitchell & Rapkin, 1954, p.76). Exploring the relationship between workplace and residence, Doug Carroll found that downtown workers lived across the metropolitan area, while those who worked in the suburbs tended to live near their places of work (Carroll, 1952). Advertising consultants conducted home interview surveys in Fort Wayne, Indiana, in order to understand the potential exposure of drivers and their passengers to outdoor advertisements (Bureau, 1947). A 1948 study in marketing similarly explored the share of travel costs borne by consumers in the total cost of their shopping activities (cited in Mitchell & Rapkin, 1954).

It was from these developments in thinking about the effects of distance on social interaction, as well as the metropolitan distribution of homes, workplaces, and shopping centers, that two city planners, Robert Mitchell and Chester Rapkin, published an analysis of urban traffic as a function of land use. Based on a survey of patrons at different types of businesses - a department store, a specialty shop, a service establishment, and a theater - they concluded that the nature of an establishment - the land use of an urban parcel - could help predict trips made to it. In other words, they tried to measure the respective gravity or "valence" of those establishments; the force of attraction or repulsion relative to other establishments. Based on those surveys, they developed a provisional method of modeling the distribution of urban trips between different land uses. Mitchell and Rapkin (1954) concluded that "in terms of traffic and planning, a land use arrangement which has a variety of uses is superior to one which has segregation of uses; variety spreads the traffic burden, while segregation concentrates it" (p.175). While their methods and interest in land use would carry forward, this particular finding found little traction in the error of highways.

At the time, origin and destination surveys did not include questions about the types of establishments and land uses at travelers' origins and destinations. Doug Carroll led the most expensive and extensive origin and destination study of the 1950s. Employing 360 people over a decade beginning in 1955, the Chicago Area Transportation Study (CATS) was the first to put Mitchell and Rapkin's findings into practice, including questions about establishments and land use in its home interview surveys.

Land use data wasn't easy to come by, though. No comprehensive maps or database of land uses existed; they had to construct it. To do so, the CATS team referenced public utility meter cards, insurance atlases, and aerial photos. Alan Pisarski worked with Doug Carroll in the early 1960s, after Carroll had moved from Chicago to work on an origin and destination study in the New York metropolitan area. In the absence of land use maps, Pisarski remembers field workers surveying all of Manhattan on foot (personal communication, February 14, 2013). They complemented such manual surveys with fire insurance maps, known as Sanborn maps, and advice from real estate professionals. Applying Mitchell and Rapkin's theories on a grand scale, these pioneering metropolitan transportation studies sought to understand how transportation interacted with people's life cycles, their expenditures, and their culture. Land use provided critical data for understanding the motivations for trip-making.

Transportation Planning Spins Off

Influenced by developments in the field of sociology that sought to render qualitative observations of social phenomena into mathematical functions for forecasting, transportation studies sought to move beyond mere description to quantified explanation; to render qualitative observations into mathematical functions for forecasting and highway planning. They sought to derive explanatory and operational functions, and the key to explaining movement was in access to activities on the land. In order to make such forecasts, CATS took inspiration from the work of Reilly, Zipf, and Dodd, as well as Mitchell and Rapkin.

The idea was to develop a mathematical model to account for the relative attractive force of a parcel's unique mix of land uses and development, as well as the friction or hindrance of distance. Carroll (1957) described the CATS model in terms of "intervening opportunities," a phrase taken directly from the work of the sociologist Samuel Stouffer. Stouffer, a contemporary of Zipf and Dodd, had developed his intervening opportunities model to relate the mobility of migrants to the distance they traveled in migration. Morton Schneider developed the intervening opportunities model further at CATS. A 1962 BPR report describes the model in this way: "The opportunity model distributes trips on the theory that each zone has a stated probability of being acceptable as a destination for work, shopping, etc., and that people want their trips to be as short as possible. The probability that a zone is acceptable is proportional to the size of the zone and inversely proportional to the trips which have not yet found a desired destination. The competing-opportunities model theorizes that only zones within specified time limits of travel compete for trips from all other zones, and these zones compete in accordance with the size of the zone" (Bureau of Public Roads, 1962, p.36).

Alan Voorhees was a graduate student in transportation engineering at Yale before he joined the Automotive Safety Foundation and helped cities lobby for the 1956 Highway Act. At Yale, he wrote his thesis in response to Mitchell and Rapkin's land use approach to modeling urban traffic. As an alternative, he offered his own "general theory of traffic movement," using Reilly's Law of Retail Gravitation to argue that

distance mattered more than land use, per se, in the distribution of trip origins and destinations. Impedance, in other words, was more significant in determining people's travel behavior than their desire. Voorhees was primarily interested in estimating future travel to new developments, such as suburban shopping centers, which were growing to replace neighborhood corner markets and also increasing driving. He later commercialized his "gravity model," and improved versions of his method are ubiquitous today.

Conclusion

Computers played a crucial role in making large-scale transportation studies possible, but several contemporary accounts highlight the importance of social science research in helping to quantify behavioral variables for planning. The study of travel as a function of land use would not have been possible without computers, according to a former director of the BPR (Holmes, 1973), "but the application of the new technology could not have been implemented without converting the land-use inventories and projections from a qualitative to a quantitative basis and bringing into the planning process, up until then carried on largely by engineers, professionals from other disciplines who were better equipped by training to deal with the factors of land use and urban growth" (p.382).

A 1962 report of the BPR also acknowledges the important role of interdisciplinary cooperation in the development of rational planning methods, and called for continued collaboration, as well as the consolidation of highway engineering with city planning: "The introduction of new engineering skills and of disciplines not heretofore generally associated with transportation – for example, that of the geographer and the sociologist – as well as that of the economist and planner, will be needed. The gap between the conceptual approach of the city and metropolitan area planners and the quantitative approach of the highway planner must be bridged" (Bureau of Public Roads, 1962, p.36). As one transportation planner of the era told me: "We're talking about the movement of people, about how people live. It's not an engineering problem. It's a social problem" (Gilbert, personal communication, March 7, 2013).

All of this innovation in engineering and planning methods took place before the Interstate Highway System was even created. This history therefore demonstrates cities' desire for planning to solve the problem of urban traffic congestion as a primary motivation for their support of the 1956 Federal-Aid Highway Act. Later highway legislation would make planning mandatory, including statistical forecasting of travel demand based on the gravity model. These tools - spinoffs of a previous era of mobilities research in the social sciences - continue to shape urban transportation systems today.

References

Adey, P. (2004). Secured and sorted mobilities: Examples from the airport. Surveillance and society 1: 500-519.

Bureau, T. A. (1947). *Methods for the Evaluation of Outdoor Advertising; Based on a Pilot Study in Fort Wayne: Conducted by The Traffic Audit Bureau, Inc., Spring 1946*. The Bureau. Cited in Mitchell, R. B., & Rapkin, C. (1954). *Urban traffic: A function of land use.*

Bureau of Public Roads. (1954). *Highway progress.* Washington, D.C.: U.S. Department of Commerce, Bureau of Public Roads.

Bureau of Public Roads. (1962). *Highway progress.* Washington, D.C.: U.S. Department of Commerce, Bureau of Public Roads.

Butcher, M. (2011). Cultures of commuting: The Mobile negotiation of space and subjectivity on Delhi's metro. Mobilities 6(2): 237-254.

Campbell, M. E. (1950). Route selection and traffic assignment. In *Highway Research Board, Washington, DC*.

Carroll, J. D. (1952). The relation of homes to work places and the spatial pattern of cities. *Social Forces*, *30*(3), 271-282.
Carroll, J. D. (1957). Future Traffic Predictions for the Detroit Area. In *Highway Research Board Proceedings*.

Casey, Jr., H. J. (1955). The law of retail gravitation applied to traffic engineering. Traffic Quarterly, 9(3), 313-321.

Creswell, T. (2003). Theorizing place. Thamyris/Intersecting: Place, sex and race 9(1): 11-31.

Creswell, T. (2006). *On the move: Mobility in the modern western world*. New York: Routledge.
Dalakoglou, D. (2010). The road: An ethnography of the Albanian–Greek cross-border motorway. American ethnologist 37(1): 132–149.

Dalakoglou, D. (2012). 'The road from capitalism to capitalism': Infrastructures of (post)socialism in Albania. Mobilities 7(4): 571-586.
Dant, T. (2004). The driver-car. Theory, culture and society 21(4-5): 61-79.

Dodd, S. C. (1950). The interactance hypothesis: a gravity model fitting physical masses and human groups. *American Sociological Review*, *15*(2), 245-256.

Featherstone, M., Thrift, N., & Urry, J., eds. (2005). *Automobilities*. London: Sage.

Gilbert, K. (2013, March 07). Interview by C Deutsch [Web Based Recording].

Heanue, K. (2013, January 17). Interview by C Deutsch. [Web Based Recording].

Holmes, E. H. (1973). The state-of-the-art in urban transportation planning or how we got here. *Transportation*, *1*(4).

Jain, S. S. L. (2002). Urban errands: The means of mobility. Journal of consumer culture 2(3): 385-404.

Jain, S. S. L. (2004). "Dangerous instrumentality": The bystander as subject in automobility. Cultural anthropology 19(1): 61-94.

Koshar, R. (2004). Cars and nations: Anglo-German perspectives on automobility between the world wars. Theory, culture & society 21(4/5): 121-144.

Laurier, E. (2011). Driving: Pre-cognition and driving. In Cresswell, T., & Merriman, P., eds. *Geographies of mobilities: Practices, spaces, subjects*. Farnham and Burlington, VT: Ashgate, 69-82.

Laurier, E. (2004). Doing office work on the motorway. Theory, culture & society 21(4/5): 261-277.

Lewis, T. (1997). *Divided highways: Building the interstate highways, transforming American life*. New York, NY: Viking Penguin.

Lutz, C. (2014). The U.S. car colossus and the production of inequality. American Ethnologist 41(2): 232-245.

Merriman, P. (2009). Automobility and the geographies of the car. Geography Compass 3(2): 586-589.

Meyerson, M. E. (1955). Implications of sociological research for urban passenger transportation policy. In *Highway Research Board Proceedings.*

Mitchell, R. B., & Rapkin, C. (1954). *Urban traffic: A function of land use.*

Oi, W. Y., & Shuldiner, P. W. (1962). *An analysis of urban travel demands.*

Owen, W. (1956). *The metropolitan transportation problem*. Washington: The Brookings Institution.

Paterson, M. (2007). *Automobile politics: Ecology and cultural political economy*. Cambridge: Cambridge University Press.

Pisarski, A. (2013, February 14). Interview by C Deutsch [Web Based Recording].

Rose, M. H., & Mohl, R. A. (2012). *Interstate: Highways politics and policy since 1939*. (3rd ed.). Knoxville: University of Tennessee Press.

Sadana, R. (2010). On the Delhi metro: An ethnographic view. Economic & political weekly XLV(46): 77-83.

Schmidt, R. E., & Campbell, M. E. (1956). *Highway traffic estimation.*

Sharrock, W. W., Hughes, J. A., & Martin, P. J. (2003). *Understanding modern sociology*. London: Sage.

Sheller, M. (2011). Mobility. Sociopedia.isa.

Sheller, M. (2004). Automotive emotions: Feeling the car. Theory, culture & society 21(4/5): 221-242.
Sheller, M., & Urry, J. (2006). The new mobilities paradigm. Environment and planning A 38: 207-226.

Taussig, M. (1991). *The nervous system*. New York: Routledge.

Thrift, N. (2003). Movement-space: The changing domain of thinking resulting from new kinds of spatial awareness. Economy and society 33: 582-604.
Truitt, A. (2008). On the back of a motorbike: Middle-class mobility in Ho Chi Minh City, Vietnam. American ethnologist 35(1): 3-19.

Urry, J. (2004). The "system" of automobility. Theory, culture & society 21(4/5): 25–39.

Uteng, T. P., & Cresswell, T., eds. (2008). *Gendered mobilities*. Farnharm and Burlington, VT: Ashgate.

Valverde, M. (2011). Seeing like a city: The dialectic of modern and premodern ways of seeing in urban governance. Law & society review 45(2): 277-312.

Voorhees, A. M. (1956). *A general theory of traffic movement*.

Zipf, G. K. (1946). The P 1 P 2/D hypothesis: on the intercity movement of persons. *American sociological review*, *11*(6), 677-686.