Uneven Mobility: Injustice in Accessibility and Urban Experimentation

by

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Abstract

We all transport ourselves from place to place to live life in this connected world. Academics call the ease by which we can do so *accessibility*. Yet, the uneven distribution of accessibility, particularly the immobility of the disadvantaged, continues to be a profound injustice. A long history of automobile-oriented and engineering-focused transportation planning has been dominated by powerful political and economic actors to continue to perpetuate this status quo. Taking accessibility as the major outcome of interest, this thesis charts underrecognized routes to realizing more just outcomes in two parts. The first part explores the possibilities of new representations of space in changing a discourse. It does this through creating a collaborative accessibility tool (https://accessmichigan.mit.edu/) using the latest mapping and web development libraries, with iterative feedback confirming the potential of the idea. By highlighting accessibility, it starts to spur discussion of what the transportation system is for and how we might shape more just outcomes. The second part takes issue with current conceptions of urban experimentation as neglecting important sites of agency. It consists of three deep case studies of urban experimentation in SE Michigan: *EZ Ride*, a technologically enabled coordinated community-based transportation service; *refleX,* a city-suburb collaboration for a well-marketed, limited-stop express bus service; and *Night Shift,* a ride hailing subsidy pilot with reflexive feedback and iterative processes. Upon framing these experiments as processes, the case studies show that urban experimentation represents a site of concentrated possibility, and can change the rules of the game through supporting new coalitions or building organizational capacity. The thesis integrates both parts to identify these three specific mechanisms of institutional change: 1) changing the discourse, 2) rearranging networks of actors, and 3) learning by doing. In the hands of motivated bottom-up actors, these can be meaningful routes to start chipping away at the systems shaping urban mobility today and making steps towards a future that is more mobile and just.

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Chapter 1: Introduction

The ability to get where you need to go is a ubiquitous requirement for participation in today's connected world, whether it be to doctor's offices, schools, jobs, loved ones or just anything that is helpful for living our lives. Academics call this *accessibility*, and define it as the core purpose of transportation systems. Yet, the uneven distribution of accessibility, particularly the immobility of the disadvantaged, continues to be a profound injustice. Even more so, this distribution is only a loose indicator of deeper deliberative, procedural, restorative, and epistemic injustices that privilege some people's freedom and control of movement over others' (Sheller 2018).

Although we encounter the transportation system today as a behemoth forged in steel and concrete, the now ordinary ways we get around have been shaped and supported by humans across history. Humans drive the buses we ride, design the technologies that carry us, maintain and construct the massive network of infrastructure, and ultimately plan and decide what should be built and when. We might call the circumstances that shape the transportation system an urban mobility regime, filled with rules, norms, and relationships between decision makers. The dominant urban mobility regimes in the US and many other parts of the world continue to reproduce a situation where many people face great difficulties in getting where they need to go, and the car becomes a necessity out of reach for many.

This thesis is motivated by a desire for alternatives. Though many may blame the omnipresent "system", calling for nothing less than a complete revolution, perhaps there are meaningful incremental efforts and strategies available to us all. Taking control of these underrecognized sites of agency can be a helpful step towards realizing a future that is collectively more mobile and just.

1.1 Theoretical background

The analytical framework I will use for understanding the injustices of the current urban mobility regime centers three interrelated conceptual elements: *planning*, *knowledge*, and *power*. Throughout history, certain arrangements of these have led to the current moment that severely disadvantages the immobile. This thesis highlights and pushes forward stories and approaches that are often excluded, forgotten, or disregarded.

1.1.1 Planning

Planning as a concept is ill-defined and contains many contradictions. In a broad and noncommittal definition, planning can be considered "an intervention with an intention to alter the existing course of events" (Fainstein and DeFilippis 2015, 8). In this, planning is not merely "making plans", but encompasses a whole process of purposive intervention, from vision to action. What this definition does not specify is *who* does planning, *which* visions get implemented, and *why* planning happens in the first place. Throughout planning's conventionally taught history, planning is meant to be done by government in conjunction with "great men with great ideas" (6), subjected to scientific rationality, and in pursuit of "progress" and "modernity" for society (Graham and Marvin 2001). Often neglected are the meaningful bottom-up interventions such as small scale urban design interventions akin to tactical urbanism (Brenner 2015), service delivery through community organizing (Fernandez 2003), and community control efforts such as community land trusts and housing cooperatives (DeFilippis 2003).

Even this broad definition of planning is contested and is highly influenced by classical liberalism. Marxist deterministic interpretations of planning deemphasize individual agency for the structural

workings of the capitalist system. In their view, planning is "state intervention", which greases the wheels of capital accumulation while maintaining democratic legitimacy—not so much due to the spontaneous visions of the capitalist, but rather stemming from structural economic necessity (Foglesong 1986). Though a rich line of inquiry, these approaches neglect the variety of planning outcomes, and downplay real and existing community power. This thesis will treat planning according to the "purposive intervention" definition.

What is planning *not*? Planning is frequently contrasted with laissez-faire and the market system. Planning means purposive coordination or top-down imposition while the more evident "politics" means fair bargaining between political groups (Foglesong 1986). Many have used these distinctions to advocate for "anti-planning". Anti-planning sentiment from the right reacts to the large scale and expensive public works projects of planning's history to advocate for the use of the maximally efficient market mechanism. Anti-planning sentiment from the left (Marxists) react with Albert Hirschman's "thesis of perverse effect"—in which the consequences of specific interventions are often the exact opposite of intended effects (Banerjee 1993). Planning then becomes a detrimental detraction from the ripening of capitalism's contradictions that eventually bring about revolutionary social change.

"Although there are few academic planners who would claim that planning is a wholly technical and therefore unbiased field, the behavior of planners over the last century suggests otherwise."(Doan 2011, 3). The academic literature also recognizes that conceptions of planning are in constant flux, and might be better understood as a culture shaped by social, political, and technological processes (Vale 2008, 71) rather than rooting in a substantive or essentialist definition (e.g. planning as managing the built environment).

This thesis draws from rich academic critiques to bring alternative answers to planning's questions of *who, which,* and *why* to the fore. By investigating concrete examples of planning including community members, advocates, and grounded practitioners, it explores planning's potential to realize bottom-up visions furthering social justice. Recognizing the potential for bottom-up actors also highlights the need to acknowledge alternative forms of knowledge.

1.1.2 Knowledge and technology

Since the seventeenth century, modernist science based in empiricism—"observation, hypothesis, experiment; the search for mathematically best laws of nature; and a sharp distinction between reason and emotion" (Sandercock 1998, 59)—has dominated the epistemological[1] landscape, contributing to a consolidated Western dominance (de Sousa Santos 2008). With this came a commitment to one side of some of humanity's age-old unanswerable questions: Is the world objective (positivism) or socially constructed (hermeneutics)? Is science shaped by the logical structure of the scientific method (Popper) or the social interactions and strategies of human scientists (Kuhn)? Does valid knowledge only come from theoretical reasoning and application (Plato) or is there room for intuition, imagination, and emotion (Aristotle)? In this context, the implications are that only those voices that submit to the foreign language of empirical science are given legitimacy in the planning process.

Social science and planning scholarship have long struggled with the empiricism of natural science. Some schools of thought seek to fit questions of human behavior and society into the empiricist mold, using statistical models and experiments to find generalizable social truths. Some have stayed steadfast

[1] Referring to the study of knowledge, its methods, validity, and scope.

supporting a constructivist tradition based in individually contextualized qualitative and theoretical inquiry. Given that this dichotomy has provoked unproductive mudslinging within the academic community[2], others propose a third way. Flyvbjerg (2001) draws from Aristotle's *phronesis*, loosely translated to practical wisdom, to advocate for its centrality within a more meaningful social science. Recognizing the explanatory and predictive power of natural science empiricism, Flyvbjerg calls upon social science to focus on reflexive analysis and discussion of values and interests, precisely where natural sciences are sorely lacking. Put another way, Donald Schön and science and technology studies (STS) scholars such as Sheila Jasanoff recognize natural science's problem *solving* abilities, but see the potential of social sciences in studying the values-driven social factors that dictate problem *setting*, the process by which we make sense of a situation and identify what is wrong and what needs changing (Sandercock 1998; Jasanoff 1996).

Critiques of the dominance of this Enlightenment empiricism are rooted in an acknowledgement (knowing) of epistemological diversity, in contrast to a modernist scientific monoculture (de Sousa Santos 2008). A diverse body of feminist perspectives highlight the gendered production of knowledge, especially problematizing women's historical identification as irrational, in favor of non-binary logics (i.e. acknowledging both reason *and* emotion) and a recognition of subjectivity and historical contingency. Other postmodern critics such as Foucault center the "dark side" of Enlightenment thought by highlighting the links between knowledge and power (Sandercock 1998). Hayek (1948, chap. 4) is fearful of an overbearing technocratic state, and in his exaltation of the market as a necessary collective knowledge endeavor notes that "the problem is one of the utilization of knowledge not given to anyone in its totality". Dewey (1946) similarly criticizes the Enlightenment "spectator theory of knowledge" and focuses on the praxis of constant rediscovery of knowledge through "learning by doing". For Dewey, this happens under democracy as living in and discovering the world, collectively with others, though like the modernists is rooted in experience rather than solely the mind (Claudel 2020).

Technology is knowledge's application into a way of organizing the world that has material effects (Claudel 2020; Winner 1986). Given alternative conceptions of knowledge as non-singular, emergent, and subjective, technology as well does not a follow a deterministic path. Winner (1986, chap. 2) argues that many technologies possess "intractable properties [that] are strongly, perhaps unavoidably, linked to particular institutionalized patterns of power and authority" (38). In this case, a technology and the knowledge that produces it are a mechanism by which existing power relations exert themselves in the material world.

This thesis uses Dewey's pragmatism in interpreting examples of planning. It investigates the process by which planners learn about the material world or social and political context, and recognizes that learning by doing is an important route. Methodologically, it takes Dewey as a validation of a process of participatory research where I make my own incremental intervention and build relationships with planners to learn more about how things get done. By opening the space for alternative forms of knowledge and technology, it also finds the potential to reorder existing power relations.

[2] Big example is the "Science Wars" at the center of Flyvbjerg (2001)

1.1.3 Power and institutions

> *"Power properly understood is nothing but the ability to achieve purpose."* - a late and radicalizing Dr. Martin Luther King Jr. during a speech entitled "Where do we go from here?" at the 1967 SCLC annual convention (King Jr. 2015)

If planning is purposive intervention, legitimated and supported by knowledge and technology, *power* addresses the questions of "by who?" and "for which purposes?". Dr. King makes clear a broad interpretation of power as the ability to affect change, though many social scientists such as Max Weber focus on power as the ability to affect the behavior of others. Dr. King's humanist conception of power contrasts with Nietzsche's identification of love and power as polar opposites. His rhetorical ability and clarity outline this case:

> *"What is needed is a realization that power without love is reckless and abusive, and that love without power is sentimental and anemic."* (Ibid.)

Dr. King's approach to power is in line with many community development scholars and activists, and is interesting to compare to Foucault's analysis.[3] Foucault's observation that "power is everywhere" and "comes from everywhere" (Foucault 1976, 93), not limited to the use of force by the state, came at a time where liberal views of sovereign power became the exclusive running definition. Foucault also countered the traditional view of power as purely negative, synonymous with repression, coercion, and exclusion, and similar to Dr. King considers power as productive within society— producing things, inducing pleasure, forming knowledge, and producing discourse (Foucault 2001, 120). Within all of this, Foucault defines power as relational among agents, meaning that it is defined by power relations in which people's actions have effects on another's actions (Foucault 2001). Power is also inevitably intertwined with knowledge, in which Foucault borrows from Gramsci's "hegemony" and Althusser's "ideology" to argue that power is exercised through a subjective knowledge and discourse, acting more insidiously through normalizing and convincing subjects of the status quo.[4] Most jarring is Foucault's leaning towards a structural view of power, separate from the humanist focus on the agents that exercise it. From this, many come away from reading Foucault with a hopeless feeling towards practical action.

Dr. King and Foucault both call for a recognition of the diversity of sources of power beyond the logic of legitimation of the role of the state within classical liberalism. Acknowledging this diversity is a first step

[3] A full synopsis of Foucault's work on power is out of scope for this thesis. All that is here is a first step into their thoughts and frameworks.

[4] Here is a perplexing statement from Foucault's later writing: "My objective, instead, has been to create a history of the different modes [of objectification] by which, in our culture, human beings are made subjects." By subject here, Foucault refers to both the definition of the "subject" in the subject-object dichotomy in philosophy, as conscious agents possessing subjectivity (the "self"), as well as the definition of the "subject" as one who is subject to societal forces. https://cluelesspoliticalscientist.wordpress.com/2018/08/17/the-subject-and-power-by-michel-foucault-a-summary/

towards understanding the multitude of ways that "things get done" in society. A list of some of these sources is synthesized below:[5]

1. **Violence**: The use of physical force is an inefficient way of enforcing one's will, though it is a popular vision of power. This is the power of those who can control the police or the military. Foucault extends upon existing conceptions of force with his concept of power-knowledge, something far more insidious and influential. When physical force is legitimated and normalized, surveillance and the mere thought of force can exert a strong influence.
2. **Wealth**: Another valid popular conception of power is that of sheer material wealth, essentially a highly convertible form of power. For Marx, this power comes from one's relation to the modes of production, differentiating different classes. For others, examples are abound in political science literature of the influence of money in politics, one recent example being platform companies spending $200M to pass California's Proposition 22 in 2020.
3. **Legitimacy of the state**: In the liberal paradigm, the state is given power over its subjects from the legitimacy of a social contract in order to maintain society's "rules of the game". Though perspectives on how much power should be given to the state varies from an all-out aversion to Leviathan to a government centered Keynesianism, liberals fixate on the rule of law and the state as an allowable deviance from an otherwise pure "state of nature".
4. **Normalization and culture**: Social norms are a way of cementing certain ways that "things get done" in society. Foucault argues a particular form of this, in which the disciplining of docile bodies in mental institutions, schools, and prisons is "essential to the general functioning of the wheels of power" (2001, 117).
5. **Ideas and innovation**: Technologists might argue that their source of power comes from their ability to innovate "better" material things or operational models— an ability to "problem solve".[6] Classical social science conceptions of power usually disregard the agency of technologists, but those closer to technology recognize the variation and open-endedness in technical design.[7]
6. **Protest**: A growing contingent of community activists focus on the power of protest within everyday people (Carruthers 2018). As shown by the recent Black Lives Matter movement and many other movements in the past, the power of an organized and collective voice can change the way things get done. This thesis seeks to amplify this source of power as an important voice for justice.

Given the multitude of sources of power, *institutions* are the ways that power relations are cemented over time. For the purposes of this thesis, institutions are defined as the rules, sets of practices, and norms that shape social, economic, and political relationships between actors (Scott 2014). Institutions can be formal, as in public policy and law (North 1990), or informal, embedded within cultures. Institutions comprise an urban mobility regime, and affect the network of power relations among actors.

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[5] This list is roughly inspired by Eric Liu's liberal-oriented *You're More Powerful Than You Think* (2017), meant for a popular audience. Liu starts with a fairly comprehensive list of the "sources of power" (50) including influences from liberalism (physical force, state action), Foucault (social norms), and other intuitive examples (wealth, ideas).
[6] Cornel West calls this "smarts" but not necessarily "wisdom" in a talk at MIT entitled "Speaking Truth to Power", https://youtu.be/-Bc6TRjptKI?t=1979.
[7] This is an overarching theme of the MIT Task Force on Work of the Future and the charge of human-centered design literature.

Institutions can also be taken as the full combination of the shaping forces of planning, knowledge, and power above. This thesis uses an institutional lens in framing an investigation of institutional change as the "systemic change" long sought by advocates.

1.2 Application to urban mobility

Applying the above framework to urban mobility[8] reveals points of contention with current practice. As a preface, Figure 1.1 shows a rendition of the transportation planning process by the US Department of Transportation. The figure focuses on a traditional process carried out by transportation planners, from goal setting and vision-making in long-term plans, down the chain to short term operational plans. Throughout this process, travel demand modelers use demographic projections to predict travel demand by mode via the traditional "four-step model" (McNally 2007). A bare minimum of public participation is required by Title VI of the 1964 Civil Rights Act, though oftentimes these public meetings are poorly attended or inconsequential (Sutcliffe and Cipkar 2017).

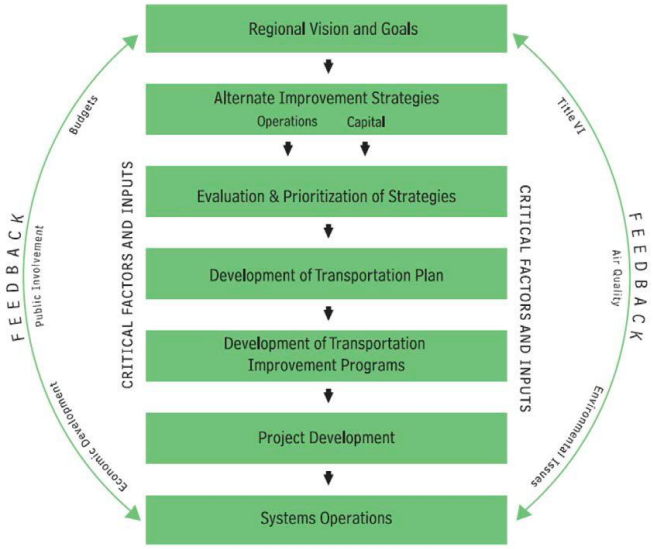

Figure 1.1 - One View of the Transportation Planning Process (FHWA and FTA 2015)

Though this may well describe a large portion of how transportation planning currently and formally gets done, its objectification and professionalization has led to the dominance of a specific set of values and control by top-down or "expert" actors. Often neglected are how the field's slew of performance metrics such as level of service obscure a normative bias towards automobility, feeding public visions of automobility as a "natural product of consumer demand and technological progress" (Culver 2015). This technocratic emphasis also covers up the influence of business and political actors in urban mobility throughout history to the present (Weinstein 2006; Lowe and Grengs 2020). "Car *culture*" fuels a public support for automobility and a stigma for bus riders, normalizing and glorifying automobile use far beyond its instrumental value (Moody 2019). Voices and rights of those who do not own an automobile—pedestrians, cyclists, transit riders, and so on— are disadvantaged by this arrangement of

[8] "Urban mobility" is used interchangeably with "transportation" in this thesis. It does not aim to limit to a focus on the city, but to evoke a cultural meaning of the word separate from entrenched views of "transportation".

planning and knowledge into "uneven power geometries" exercised through the sources of power outlined above (Prytherch 2012).

Despite the importance of technocrats in urban mobility, there are examples of bottom-up planning, non-"expert" forms of knowledge, and the power of protest exercised by a community, highlighting a key site of agency for justice. The freeway (and transit) revolts in the 1950's and 1960's across the United States and elsewhere, mostly by white affluent urban neighborhoods, show how bottom-up action can affect the transportation landscape, albeit oftentimes through stopping projects rather than building them (Henderson 2013). As some have noted, the remnants of the concerted anti-highway movement persist within current contestations over issues such as neighborhood gentrification (Crockett 2018). However, the new battlegrounds of mobility do not see the same community organizing strength[9], and are receding from the state-public relationship towards a multitude of "governance" actors (Harvey 1989).

1.2.1 Why Southeast Michigan?

This thesis takes the Southeast Michigan region as a case study of an urban mobility regime producing evident mobility injustices. These surface in high-profile media stories such as of the "21-Mile Man" with a tolling ten hour commute, much of it on foot, from Detroit to his job in the suburb of Rochester Hills.[10] A well-developed literature attributes these outcomes to automobility and its coproducers—state-sponsored suburbanization of residents and jobs, racial animus and white flight, and a political culture of adversarial localism (Hackworth 2019; Thomas 1992). Given that this situation is common among cities across the US and around the world, studying SE Michigan can yield some generalizable insights into the institutions of urban mobility everywhere.

This thesis also stress-tests explanations of mobility injustice in the region's unique situation. Southeast Michigan is unique in historically being a source of worldwide automobility, from the region's economic development stake in the automotive industry to its early lobbying for a federal highway system in the 1950's to its role in promoting car culture. The City of Detroit harbors a particular situation of urban decline, fiscal bankruptcy, emergency management, and austerity measures (Dewar et al. 2015). The region's current moment is also atypical, with the diversification of inner ring suburbs, a pragmatic but optimistic spin on new mobility technologies[11], and an emerging speculative urban growth machine connected to multinational capital spearheading Detroit's "renaissance".[12] Thus, this thesis pursues the dual purpose of contributing to theories of the general while situating the practical options of the particular.

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[9] Not to invalidate meaningful current efforts by transportation advocates (e.g. MBTA fare protests, efforts by Detroit People's Platform, Motor City Freedom Riders, and Transportation Riders United in Detroit), transit union workers (e.g. DDOT strikes during the pandemic, NYC Bus Drivers Union refusing to transport arrested protestors during the summer of 2020), and platform workers (Wells, Attoh, and Cullen 2020).

[10] Bill Laitner. "Heart and sole: Detroiter walks 21 miles in work commute". *Detroit Free Press*. Feb. 10, 2015. https://www.freep.com/story/news/local/michigan/oakland/2015/01/31/detroit-commuting-troy-rochester-hills-smart-ddot-ubs-banker-woodward-buses-transit/22660785/

[11] Some examples of this include a regional emphasis on vehicle-to-infrastructure communication and connected instead of completely driverless automated vehicles.

[12] In particular the confluence of Dan Gilbert's financial "empire", large capital and venture investments by the big automakers (e.g. Ford, GM), and an increasing presence of companies like Google or Amazon.

1.3 Research Questions and Methodology

With the goal of charting new routes towards mobility justice, this thesis asks the following core research questions:

1. How might a collaboratively oriented accessibility tool affect advocates and the public in their understanding and involvement in policy or programmatic interventions in urban mobility?
2. In what ways does urban experimentation affect the processes and outcomes of an urban mobility regime?

Answering these two questions requires a mix of quantitative and qualitative methods. For the first question, a collaboratively oriented accessibility tool must first be created, and so I conduct an accessibility analysis using standardized methodologies for a cumulative opportunities competitive accessibility measure. This takes advantage of a slew of publicly available data from the US Census Longitudinal Employer-Household Dynamics, the US Census American Community Survey, public transit agencies, and the OpenStreetMap collaborative mapping project. Calculating accessibility measures was done through Conveyal Analysis and processing through spatial analysis software. Place-based accessibility measures were then converted to people-based accessibility measures using vehicle ownership information, and finally was visualized on a dot density map with a user interface enabled by open-source libraries and web development frameworks. After the creation of the tool, one round of survey feedback was done with practitioners, advocates, and community members to gauge the viability of continued iteration.

For the second question, I present three deep case studies of urban experimentation in urban mobility. Each case study was chosen to explore underrecognized contexts within academic literature with different scales, actors involved, and political contexts. I situate each case study within a historical context through documentary analysis, and then rely on multiple semi-structured interviews with the experimenters themselves and some of their in-depth written accounts. After comparing among the case studies, important points that emerged were compared to existing theories in creating a new theory of urban experimentation.

1.4 Organization

This thesis consists of two main parts to address the research questions above.

Part I describes the whole effort of creating and soliciting feedback on a collaborative accessibility tool. Chapter 2 positions the tool within broader academic literature defining collaborative planning, accessibility, and the role of tools. Chapter 3 first reviews existing accessibility tools, and lays out the design process for a new web-based accessibility tool for SE Michigan. A preliminary accessibility analysis is carried out to update previous studies, and the functionality of the tool is explained with feedback from local stakeholders.

Part II describes the theoretical and empirical work on urban experimentation. Chapter 4 reviews existing conceptions of urban experimentation to both academics and the public. Chapter 5 consists of the stories of the three case studies—*EZ Ride*, *refleX*, and *Night Shift*— and concludes with a comparison and general conclusions arising from a view on urban experimentation as institutional change.

Chapter 6 summarizes the thesis and provides reflections on theory and practice going forward.

Chapter 2: Theory of Collaborative Planning for Accessibility

This chapter hones the broad debates from Chapter 1 into more immediate theories of transportation practice, focusing on the community of transportation planners and engineers that constitute most of who "gets things done" in transportation's everyday. In setting up the collaborative accessibility tool in Chapter 3, it begins with an overview of four models of planning practice rooted in planning theory, outlines a brief evolution of the concept of accessibility, and ends with the role of technical tools in the social production of space.

2.1 Paradigms of Planning[13]

A simplistic but useful way of positioning each of these four paradigms is Arnstein's eight-rung ladder of citizen participation (1969), widely referenced in the planning practitioner community. Within the context of the civil rights era, Arnstein argues that citizen participation is citizen *power*, and is the mechanism by which "have-not citizens, presently excluded from political and economic processes, [are] deliberately included in the future" (216). The rungs are divided into three major categories: nonparticipation, tokenism, and citizen power (Figure 2.1). Usefully, Arnstein cuts through unitary claims to citizen participation by addressing the variety of ways participation manifests. Bailey and Grossardt (2010) build off of Arnstein's work to highlight transportation's "Arnstein Gap", the gap between present and desired levels of citizen participation.

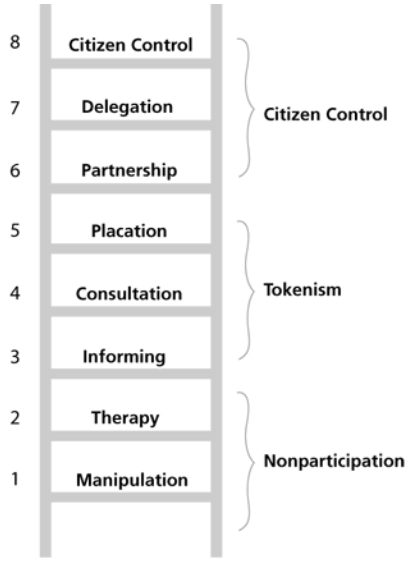

Figure 2.1 - Arnstein's Ladder of Citizen Participation (1969)

2.1.1 Technical-rational planning

The transportation planning community is one that is at a unique intersection between trained urban planners and engineers, with the latter typically dominating decision-making arenas and funding flows. Since the predict-and-provide approach started in the Interstate-building era, transportation engineers have developed sophisticated and standardized travel demand models, project pipelines, and cost-

[13] This section largely draws from Stewart (2017a).

benefit analysis procedures.[14] Their practice hinges on an insulation of transportation from contentious politics, and through this privileging the voices of technical experts. These claims to objectivity obscure the positionality and social dynamics that shape agendas and outcomes in both research and practical settings (Lowe 2020).

In Arnstein's Ladder, the technical-rational planning paradigm may require "informing" citizens of transportation projects and changes. Even when transportation professionals make informing citizens their goal through, citizens often find out about changes as they happen on the ground, when detour signs block their path or when the bus does not arrive. This insularity of transportation engineers to other perspectives or priorities is a significant barrier to current efforts to address transportation's role in social, racial, and environmental crises.

2.1.2 Advocacy planning

In reaction to the technical-rational planning paradigm that led to urban renewal, Davidoff (1965) called for a system of "advocacy planning" inspired by the adversarial legal system.[15] In his pluralist vision, he called for each interest group to have planners to create separate plans. How these would be paid for or how plans would finally be chosen (i.e. through "debate") was left unspecified. This movement did indeed help secure legal mandates for citizen participation, but has yet to fulfill its goals for broader empowerment of disadvantaged groups (Stewart 2017a).

Davidoff's ideal of advocacy planning is not widespread in transportation, and even small-scale efforts have faced difficulties from transportation's regional scale and lack of clearly specified client group (Peattie 1968). Inklings of legally required public participation inspired by advocacy planning have been characterized as a "decide-announce-defend" approach within transportation planning (Bailey and Grossardt 2010). The pluralist vision of leveling the playing field for the disadvantaged may be too optimistic when often the "users" are too saddled to speak up and the planner is too entrenched in the political economic context to advocate on their behalf (Lefebvre 1991; Stewart 2017a).

2.1.3 Communicative planning

Frustrated with the tokenism of legally required public participation structures, many scholars have taken the "communicative turn", where planning is better considered as a deliberative process, and stakeholders create mutual agreement about problems (Goodspeed 2013). They build on Habermas' (1984) theory of communicative rationality to argue that mutual preferences and interests are not static and inflexible, but discovered through discussion. Ideal conditions for this discussion include diversity and interdependence of interests, authentic dialogue, and freedom from violence or coercion (Innes and Booher 2010).

For planners, communicative planning was a much-needed reminder to strive for genuine discussion beyond the mandatory and routine public participation that still dominates practice today. However, it as a comprehensive view towards planning omits alternative forms of knowledge, accounting for

[14] Included within these is the oft maligned "level of service" (LOS) designation, a metric that ranks roads by the volume-to-capacity ratio, or in other words rewards roads for being empty and free-flowing. This is criticized as a goal to be optimized since congestion can also be taken as an ineliminable sign of desirability (e.g. in a bustling city), rather than just time wasted. Many of these procedures were codified in federal guidelines.

[15] Davidoff's reaction to technical-rational planners is encapsulated in his view on knowledge: "The right course of action is always a matter of choice, never of fact".

artifacts and real outcomes, and ultimately the institutional processes by which space and place are produced (Harvey 1996).

2.1.4 Collaborative planning

In a closely related way, incorporating local knowledge and community expertise in shaping technical analysis is one step towards truly collaborative planning. Unfortunately, the labels of "collaborative" and "co-creation" planning can be unproductively vague, though they have a sound motivation. This thesis focuses on one sliver of collaborative planning—interactions between the technically-trained planner and the public. Goodspeed (2013) explains how prior "black box" models are starting to converge with open and understandable planning support systems (PSS), engagement-oriented software to aid in classic urban planning issues such as land-use and transportation largely enabled by advances in GIS.

These PSS have the potential to engage participants in collaborative social learning, which in its most robust form focuses on the questioning of values and assumptions (Argyris and Schön 1978; see review in Goodspeed 2013). Transportation is in dire need of such a way to reflect upon its values, and has obscured its value-laden choices for many decades. This thesis takes this perspective to make an incremental push of the concept of accessibility as useful in creating an understandable technical analysis of transportation systems and refocusing on a grounded view of transportation's core purpose. Using new digital data, network tools, and interactive software can bring transportation analyses to the public (e.g. Stewart 2017b), and is a step towards transforming the discourse to advocate for more just outcomes.

2.2 Accessibility

Most would agree the transportation is a means to an end—we transport ourselves to get to the places we need to go in our lives: work, the grocery store, loved ones, etc. Though some may cherish their commutes, or might take a scenic route just to enjoy the journey, travel demand by and large can be empirically predicted from the spatial arrangement of origins and destinations (Levine, Grengs, and Merlin 2019). Accessibility put simply is a concept that encapsulates this ease of reaching services and activities as transportation's core purpose (Litman 2013).

The transportation infrastructure we build can be thought of as a network to facilitate interactions, bringing certain places closer together than their physical proximity would indicate.[16] It is also well known that current metrics informing decisions around transportation infrastructure do not plan for accessibility, but rather *mobility*. Metrics like level-of-service, delay per capita, dollars wasted sitting in traffic, all measure the ability to move around in space, but create cases where, for example, driving twice the distance to the same destination just because traffic is free-flowing becomes desirable. As the story goes, our transportation metrics are off the mark, and continually reward highway lane expansions to weed out congestion only to have it bottleneck somewhere else (Levinson, Krizek, and Gillen 2005). Congestion is better interpreted as an indicator for a desirable destination than something to avoid at all costs (by razing communities for highway construction).

[16] This can also be called the distortion of Euclidian space. For example, some mappers have created maps of subway systems that correct for how transportation networks make certain destinations closer or further apart (e.g. http://subway.nateparrott.com/). Kevin Lynch's *Image of the City* also makes clear that traditional maps are abstracted representations of space, and that transportation's configuration is key in mentally connecting places.

However, accessibility is ill-defined and subject to overuse.[17] Hansen (1959) specifies accessibility further as "the spatial distribution of activities about a point, adjusted for the ability and the desire of people… to overcome spatial separation" (73). Even with this, the inconsistency in accessibility's specification comes from the complexity of the concept, and is a major barrier to widespread adoption or use within federal standards.[18] For example, many disagree on "place" accessibility, including only characteristics of built transportation networks and land use, versus "people" accessibility, which also personal attributes like income, gender, or knowledge of transportation systems (Martens 2017). Others critique a narrow definition of "activities" as spatial destinations when, for instance, access to jobs may depend more on factors such as racial discrimination, mismatched qualifications, or lack of access to job intermediaries than transportation barriers, spilling from spatial to social (Chapple 2006; Sheller 2018; Kaufmann, Bergman, and Joye 2004). Many advocate a paradigm shift to accessibility-based transportation planning but lack a unified view on its operationalization (e.g. Banister 2008; Litman 2013; Zegras 2008; Levine, Grengs, and Merlin 2019). Such an unfocused shift would be only a small step in a larger fight for mobility justice.

2.2.1 Accessibility metrics

Though the concept of accessibility does come with limitations, it can be useful in illustrating the distributional impacts of the transportation system. To do so, transportation scholars have created many quantitative accessibility metrics to operationalize accessibility into concrete policy goals and proposals. Most of these metrics contain two elements: a transportation network and a set of activities or destinations. The competitive accessibility metric will be used in the collaborative accessibility tool in the following chapter, and a review of the diversity of metrics shows the many choices involved in accessibility's operationalization.

2.2.1.1 Cumulative opportunities accessibility

The simplest metric for accessibility is a cumulative potential opportunities measure. It counts the number of opportunities or destinations within a specified impedance[19], usually specified as a travel-time cutoff or miles traveled (Geurs and van Wee 2004). These analyses are usually specified to one type of opportunity of interest. For example, a cumulative opportunity measure of accessibility could be "the number of jobs within 30 minutes" or "the number of grocery stores within 1 mile". For ease of calculation, this can also be formalized as below where $A_i^{cumulative\ opportunity}$ is the cumulative accessibility measure for location i, opportunities d within a full set of opportunities D, travel impedance boundary c_{max}, and impedance between chosen location and opportunities c_{id}:

[17] It is important to clarify is its overlap with the identically named concept of "designing for people with disabilities" (He 2018). Though they may have the same motivation, they mean very different things in practice.
[18] Though, advocates are hopeful that access-based transportation planning can be institutionalized under the Biden Administration.
[19] Take impedance as in distance measures in computer science, which refer not to just Euclidian distance ("as the crow flies"), but are a generalization to refer to any measure summarizing relative distance.

$$A_i^{cumulative\ opportunity} = \sum_d^D f(c_{id}) \tag{2.1}$$

where,

$$f(c_{id}) = \begin{cases} 1 & if\ c_{id} \leq c_{max} \\ 0 & otherwise \end{cases} \tag{2.2}$$

2.2.1.2 Gravity-based accessibility

Cumulative opportunity measures can be seen as overly simplistic, by not differentiating between destinations within the zone. For example, a grocery store within 30 minutes may be considered "reachable", but it's a lot more convenient to have one 5 minutes away. Gravity-based measures seek to solve this problem by reconfiguring the functional form of $f(c_{id})$ in the cumulative opportunity measure. Some popular forms include:

$$f(c_{id}) = \frac{1}{c_{id}^{\rho}} \tag{2.3}$$

$$f(c_{id}) = e^{-\lambda c_{id}} \tag{2.4}$$

where ρ and λ are parameters representing rates of decay and are estimated empirically.

Gravity-based measures only require a little more specification than cumulative opportunity measures, but in general both of these methods are benefit from their mappable results and ease of explanation within a single sentence. Advocates for accessibility-based transportation planning have usually used gravity-based measures in standard practice.

2.2.1.3 Academic explorations of space-time and utility-based accessibility

Some scholars have incorporated a person's daily activity schedule into accessibility metrics using the time-space prism approach (building on Hägerstrand 1970). In essence, this approach distinguishes between activities that are fixed in time and space (e.g. a meeting, job shifts) and activities that are not. The potential path area reachable by people given fixed schedule constraints can over time be integrated into a time-space prism, whose volume can be a representation of potential for interaction. These detailed measures are rarely usable in practice and are best suited for situations with well-specified schedules such as facility planning.

Economists and engineers such as MIT's Moshe Ben-Akiva have devised utility-based measures based on random utility theory, "in which the probability of an individual making a particular choice depends on the utility of that choice relative to the utility of all choices" (Handy and Niemeier 1997). If an individual assigns an individual utility to each destination choice, accessibility can then be defined as the denominator of a multinomial logit model (the logsum). This requires a specified utility function with variables reflecting the attractiveness of a destination, the impedance to reach the destination, and individual preferences proxied by socio-economic characteristics. While economically rigorous, these measures over-specify parameters and functional forms under conditions where collecting adequate data is already difficult and interpretability is more valuable (Stewart 2017a).

2.2.1.4 Competitive accessibility

This thesis uses an extension of cumulative opportunity accessibility to jobs to account for competition. Doing so can help match lived experience in the labor market more closely. Accounting for competition also allows for comparison between cities— more opportunities does not directly translate to better access if there is a higher demand (see Stacy et al. 2020). This thesis takes Qing Shen's study of job accessibility for low-wage workers in Boston's inner-city neighborhoods (1998) as a starting point:

$$A_i^{competitive} = \sum_j \frac{Jobs_j\, f(c_{ij})}{Competition_j}; \qquad Competition_j = \sum_k Population_k f(c_{jk}) \tag{2.5}$$

This mathematical formulation is illustrated in Figure 2.2, where each job is normalized by the number of people that are able to reach it. The resulting metric has the rough units and understanding as "jobs per person", and requires a specification of a competitive population. Competitive measures straddle the line between interpretability and academic rigor, and have been commonly applied to other accessibility analysis. For that reason, this measure will be used in the accessibility tool in Chapter 3.

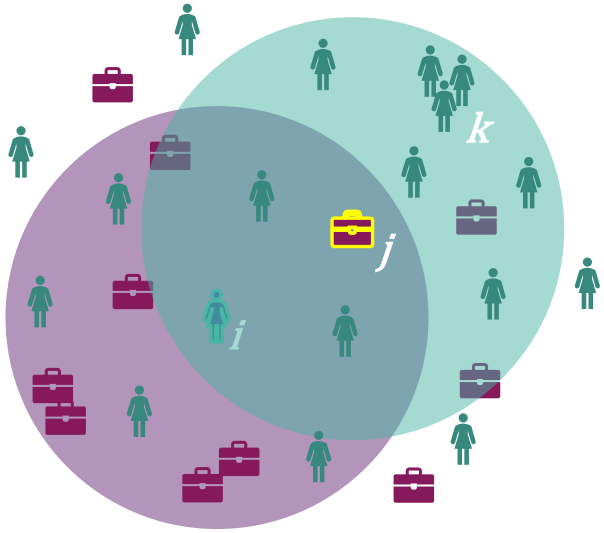

Figure 2.2 - The competitive accessibility equation normalizes each job location (purple briefcase) j *by the number of people from each location that can reach it* k *(green people within the green circle). Then to calculate accessibility for a location (green person)* i*, the equation adds up the number of normalized jobs (purple briefcases in the purple circle) in a final metric.*

Some scholars have pointed out that this competitive accessibility measure is just one step in a more generalizable iteration. After all, a person that can reach many jobs may not contribute to competition as much as a person who can only reach a few. Then, an adjusted distribution in normalized jobs again can feed into different individual contributions to competition in an iterative way. Allen and Farber (2020) take this thought to its logical end, and show that an iterated competitive accessibility measure does indeed converge to numbers that may be more standardizable across places. However, differences between high and low accessibility are preserved even after the first iteration, and so this study evades the added computational complexity for a one-step metric that is easier to implement more interpretable.

Lastly, this study uses an accessibility measure that differentiates between travel modes to account for "modal mismatch" (Grengs 2012). In essence, people who do not own vehicles must rely on other

modes of transportation, and therefore experience different accessibility than those who can drive. This thesis calculates both a transit and automobile job accessibility for each location, and then assigns individuals based on vehicle ownership estimates from the US Census.

2.2.2 Accessibility in practice

Mobility-oriented transportation still dominates, but within US metropolitan planning organizations (MPO's) accessibility is increasingly incorporated into long-term plans (Proffitt et al. 2019). Unfortunately, though many include accessibility-related goals, few define the term or use accessibility-oriented performance measures (Boisjoly and El-Geneidy 2017). Still, some examples of accessibility meaningfully informing practice include:[20]

- **Scoring project proposals**:[21] Virginia's Office of Intermodal Planning and Investment (OIPI) uses SMART SCALE to score project funding for highway, active transportation, transit, and transportation demand management facilities. Of a list of various criteria, increases in access to jobs, access to jobs for disadvantaged populations, and walking access to non-work destinations are factored into a scoring system that is effectively a cost-benefit analysis for projects. Similarly, SmartTRAC (for Transportation Rank Choices) by the Hawaii DOT includes an accessibility score for improving accessibility by non-auto modes.
- **Informing long-range transportation plans**:[22] Other MPO's have used accessibility analyses during the formulation of federally-mandated long-term plans (e.g. regional transportation plans, transportation improvement plans), often through scenario evaluation or project prioritizations (e.g. Wasatch Front Regional Council). Some have incorporated accessibility analysis into Title VI disparate impact and equity analyses (e.g. Boston Region Metropolitan Organization).
- **Benchmarking and informing about inaccessible areas**:[23] SEMCOG's Access to Core Services study benchmarked accessibility for core services such as jobs, healthcare, parks, schools, and libraries, as well as access *to* transit. They posted web visualizations with findings of their study as well, though leaving out their access to jobs analysis. The Metropolitan Area Planning Council created a Local Access Score tool as technical assistance for planners and stakeholders to improve walking and biking accessibility. The US EPA created a freely available access to jobs via transit tool among a suite of Smart Location mapping tools that encourage government agencies to develop highly accessible neighborhoods that reduce travel emissions and improve public health through active transportation.

[20] Taken from a forthcoming guide for practitioners on incorporating accessibility: Eric Sundquist, Chris McCahill, and Michael Brenneis. Forthcoming. "Measuring Accessibility: A Guide for Transportation and Land-use Practitioners". State Smart Transportation Initiative, University of Wisconsin-Madison. Other examples compiled by WSDOT: https://wsdot.wa.gov/planning/multimodal-accessibility.

[21] See http://vasmartscale.org/ and https://mauimpo.org/sites/mauimpo.org/files/document/pdf/181011_TAC%20Supplemental%20materials%20part%202.pdf.

[22] See https://wfrc.org/maps-data/access-to-opportunities/, https://www.ctps.org/lrtp-dev.

[23] See SEMCOG (2016), https://semcog.org/map-gallery, http://localaccess.mapc.org/, https://www.epa.gov/smartgrowth/smart-location-mapping. The EPA tools' interactive viewers seem to be offline, though raw data can be downloaded.

These uses of accessibility in practice still "black-box" accessibility analyses within sophisticated modeling tools used within planning agencies. As a result, even with publicly available web visualizations, they often lack interpretability and thus do not realize the concept's full potential for change. This thesis seeks to fill this gap by creating an accessibility tool that encourages dialogue with the everyday users of the transportation system.

Lastly, it's important to quickly acknowledge uses of accessibility in broader economic development literature. Work on the spatial mismatch hypothesis (SMH), or the hypothesis that workers with less spatial access to jobs have worse labor market outcomes, originated with Kain (1968) who argued that postwar suburbanization of jobs and housing discrimination led to persistent unemployment in Black communities in central cities. Inevitably, reviews of spatial mismatch literature of the decades since have not come down on one side or another, and have found that contradictory results are mostly due to measurement and methodological differences in the causal statistical frameworks (i.e. sensitivity to specification) (Jin and Paulsen 2018). I would argue that though the SMH might not be a formally objective truth resistant to statistical tests, the qualitative stories of the job barriers of those who do not have job access are enough to merit its importance for at least some groups of people. Regardless, urban economists still conduct studies of spatial mismatch, oftentimes using job accessibility metrics as regressors to predict labor market outcomes such as unemployment or jobless duration (Andersson et al. 2018). In related applications, accessibility is used as a proxy in studies of urban agglomeration economies (e.g. Melo et al. 2017). Accessibility used in these ways adds fuel to the data-oriented quantitative academic debate.

2.3 Tools

What is at stake with the accessibility shift is more than just marginal increases in efficiency. New framings can chip away at dominant paradigms that propagate racial and social injustices by transforming the slew of spatial practices that reproduce existing social relations. Lefebvre (1991) created a trialectic for reading the production of space consisting of three parts:

1. **Material spatial practices (experience)** which refer to the "physical and material flows, transfers, and interactions that… assure production and social reproduction" (Harvey 1990, 218). In the transportation context, some examples of this are: current driving patterns, hours and frequency of transit service, infrastructure, and fare payment and policing (Stewart 2010).
2. **Representations of space (perception)** which encompass abstractions of space (e.g. signs and significations, codes and knowledge) that allow material practices to be understood and discussed. This is usually dominated by technical experts, and privileges efforts at quantification. Actors appropriate and rationalize these representations into discourse to shape the infrastructure that underlies material spatial practice. The mobility metrics are one dominant representation of space, for example level-of-service represents driving patterns in a single abstracted letter grade. Representations of space also encompass non-dominant discourses, including everyday common-sense discussions and discussions of accessibility, which have much less power but can push for reflective action.
3. **Representational space (imagination)** is the space of users and inhabitants, associated with the experience of physical space and the formation of social meaning. It encompasses the discourses, utopian plans, marketing campaigns, and public meetings where visions of the future are created.

This framework is tied together with Harvey's (1990) added dimensions from a Foucauldian reading of power: accessibility and distanciation, appropriation and use of space, domination and control of space, and the production of space. Stewart (2017a) ties these concepts together (Figure 2.3) and outlines how powerful actors usually appropriate representations of space in a cycle of "circular causation" (right side) that perpetuates unjust outcomes and the resilience of capitalism (Harvey 1990). This thesis seeks to empower the non-dominant discourse of accessibility via new representations of space facilitated by web map visualization. More than adding to the long list of transportation performance indicators, it seeks to pose alternative representations, spur collective reimagination of what transportation is for (accessibility) and push an orientation towards mobility justice. This ties in with notions of social learning that are commonly associated with collaborative planning.

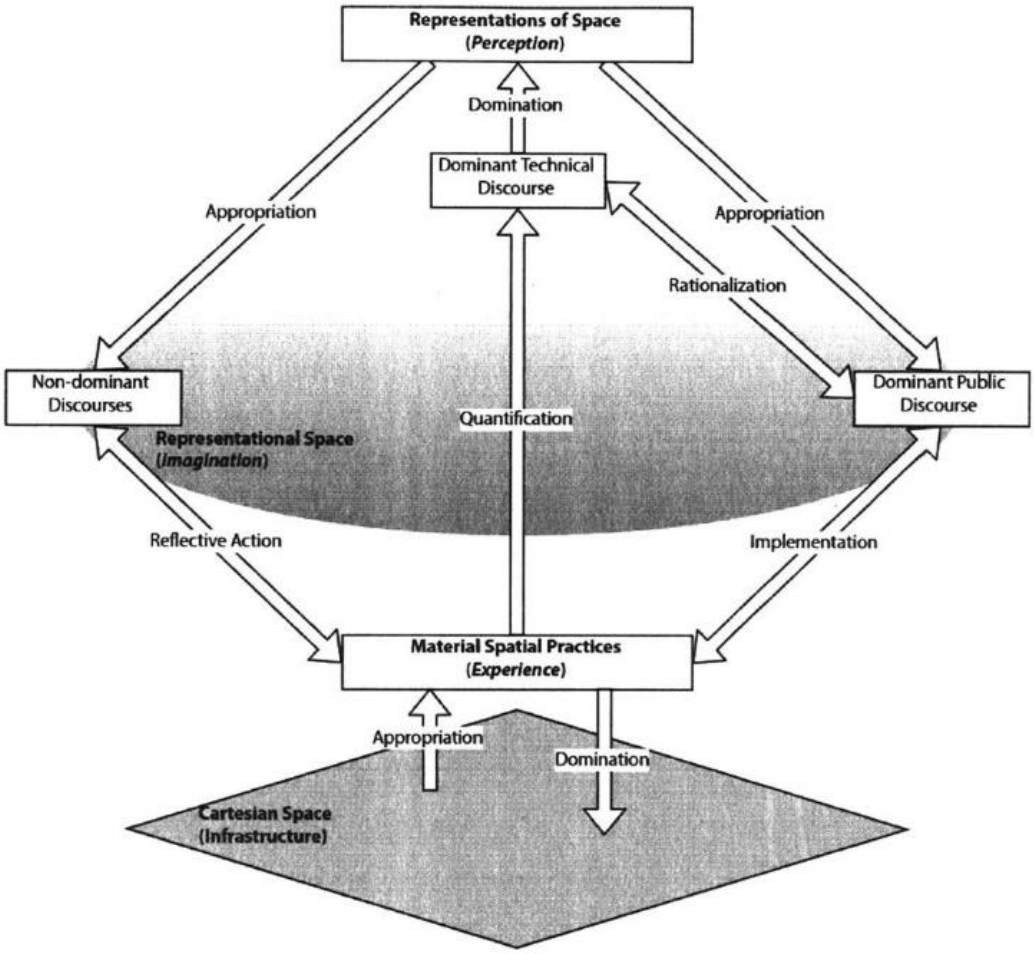

Figure 2.3 - A useful framework for understanding spatial planning (Stewart 2017a, 41)

The next chapter outlines my approach for a collaborative accessibility tool, as well as a review of existing efforts in the same vain. By enabling a broader discourse on the complexities of space and the network dynamics of the transportation system, accessibility can be used to empower stakeholders that have long been sidelined by spatial planning processes.

Chapter 3: Designing a collaborative accessibility tool to highlight mobility injustice

With the increased use of GIS in planning practice since the 1990's comes the potential of these technologies to push for meaningful public participation (Klosterman 1997). However, these computer-based representations of space rarely surface in everyday transportation practice with already problematic public engagement (Bailey and Grossardt 2010). This chapter outlines an approach to address this deficit in meaningful public engagement through a collaborative accessibility tool based on recent advances in open source software. It then provides an update to accessibility analyses for the SE Michigan region, and ends with an overview of the tool's functionality and initial feedback from stakeholders. Though not comprehensive, this incrementally contributes to a broader goal of a useful planning support system, designed to foster deliberative participatory inquiry.

3.1 Goals for the tool

No one tool can do it all—and it is important to scope out what this tool is and what it is not. To frame the discussion, we can start with cartographic literature which has explored the varying possible uses of maps along a spectrum of visual thinking to visual communication, as in the "Swoopy diagram" (DiBiase 1990) and (Cartography)[3] (Maceachren 1994). Visual thinking can be thought of as exploration and learning through maps, whether it be through analytical GIS tools (e.g. ArcGIS) or open-ended displays of spatial data (e.g. Social Explorer for Census data). Visual communication conceptualizes maps as a visual conduit for the mapmaker's ideas and information, much like story maps (DiBiase 1990). Though for many decades cartographers have focused on the latter, digital and computational tools have spurred an increased emphasis on visual thinking through more sophisticated modes of interaction (Roth 2013). Figure 3.1 applies this distinction to the context of web maps, where maps oriented for exploration and visual thinking need to be highly interactive and display information in a less hierarchical way. Meanwhile, maps oriented for presentation with too much interactivity and open-endedness would be considered overdesign (Roth 2017).

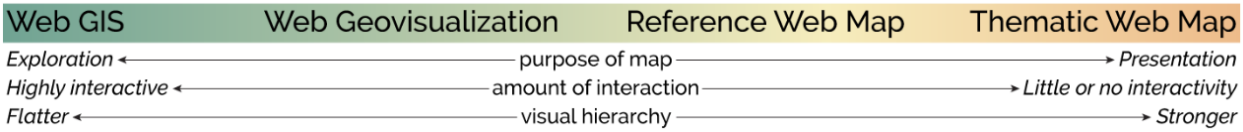

Figure 3.1 - Continuum for Webmaps (Sack 2017)

This tool aims to take advantage of recent advances in mapping and web development softwares to facilitate exploration as a precursor to the co-creation of knowledge. Importantly, it also aims to focus on accessibility and the social justice implications of SE Michigan's mobility system, and strikes a middle ground along the spectrum in Figure 3.1. Whether it is fostering visual learning or communication, this tool makes visible the previously non-visible and pushes new representations of space. These considerations have been concretized within specific goals expanded below:

1. Link personal, local, and regional views on accessibility.
2. Highlight spatial social justice implications with new representations of accessibility.
3. Maintain clarity and ease of use with minimal technical assistance.
4. Ensure open replicability for different places and interests.

Link personal, local and regional views on accessibility. The tool should allow users to be able to view how their accessibility situation fits within the regional picture. Users should be able to access a personal place at a granular level and examine how it fits within regional access. Users should also be able to compare their own lived experiences to a wider geography of accessibility. At the same time, top-down inquiries should be able to link an overall geography of access with specific places and people. With SE Michigan's history of localism and disregard for regional visions, this is an especially timely contribution.

Highlight spatial social justice implications with new representations of accessibility. In representing accessibility, one common shortcoming is limiting to an analysis of places rather than of people (Grengs 2012; Martens 2017). This makes abstract the notion of accessibility to a level that obscures the actually experienced outcomes of the transportation system that the concept illustrates. The tool's primary goal should be to showcase accessibility injustice in the region to spark a conversation, with secondary benefits in aiding the everyday practice of route redesign and transportation project implementation.

Clarity and ease of use with minimal technical assistance. Though many PSS's are centered around map-based touch tables coupled with workshops or analytical tools for scenario planning (Geertman et al. 2015, 3), this thesis seeks to create a collaborative web application without the need for planning support. Besides keeping a simpler scope to minimize edge case bugs, this also requires the use of interpretable accessibility measures and connections with actual examples.

Open replicability for different places and interests. One of the advantages of accessibility methodologies is its generalizable applicability. Coupled with an open science philosophy (Fecher and Friesike 2014), this has the potential to bridge many of the existing gaps in public participation and encourage accessibility analysis in different contexts. Central tenets of this logic include replicability, careful documentation, and open data. Efforts at open science are frequently facilitated through version control systems such as Git and cloud-based hosting services such as Github.

These goals are in stark contrast to those guiding tools in current practice, and are a promising start towards changing transportation planning's status quo.

3.2 Existing tools

The justification for this accessibility tool comes from the lack of existing tools to meet the aforementioned goals. First and foremost, there is no available tool with the same geographic bounds that uses up-to-date data. Though some planning departments have been considering accessibility, they mostly rely on proprietary software like ArcGIS and confine these insights to a technocratic realm. Lastly, very few of these tools make use of recently developed open source packages and provide full documentation for recreation by the public.

3.2.1 Accessibility tools

Starting at the onset of commercially available GIS in the 1990's, many accessibility tools have been developed. Many of these came with shortest path functions and the capability to carry out accessibility analyses close to what would be considered the standard today, albeit without the same computational ease and sleek graphics. ESRI's baseline offering of ArcView Version 3.0 (now ArcGIS), released in 1995, introduced a Network Analyst extension to facilitate automated routing for both road and transit networks (Waters 1999). Higher end packages such as ESRI's ARC/INFO and Intergraph's Microstation

and specialized packages such as Caliper Corporation's TransCAD also came with network analysis capabilities, and were released even earlier (O'Neill, Ramsey, and Chou 1992; Waters 1999). Despite the availability of these softwares, and their aspirations for participatory planning via web applications (Tang and Waters 2005), these applications were in reality mainly implemented at state DOT's for highway planning and even so took time to diffuse to local planning departments (Waters 1999). Around this time, the Suburban Mobility Authority for Regional Transportation (SMART) in SE Michigan started exploring with accessibility analyses using GIS but often limited them to assessing opportunities within a distance buffer of the transit network (Figure 3.2).

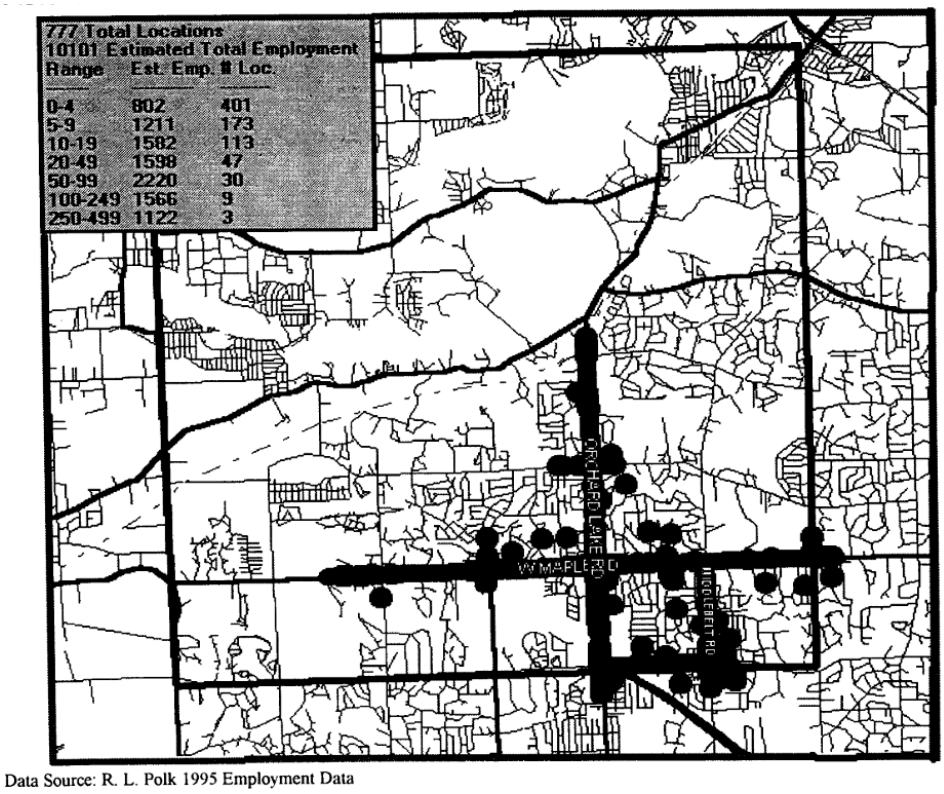

Figure 3.2 - GIS Accessibility Analysis of West Bloomfield Township, Businesses within 1/3 mile from SMART Routes. "Range" variable is firm size (Laube, Lyons, and VanderWilden 1997)

Though these advances made widescale accessibility analysis computationally feasible, these analyses necessitated creative programming work to integrate inputs and outputs from different softwares. Liu & Zhu (2004) introduced an integrated ArcView 3.2 extension known as Accessibility Analyst that integrated the Network Analyst with other ArcView extensions and ArcView's legacy programming language called Avenue. Though the authors argue that the extension is widely available, little documentation on how to obtain and use their toolkit is available—ironically inaccessible (Delafontaine, Neutens, and van de Weghe 2012). A more recent example called Urban.Access is also unavailable to the public, beyond the already great barrier of ArcGIS access (Benenson, Martens, and Rofé 2010). In the present reality, accessibility analyses in GIS consist of time-consuming and tedious steps manually integrating different software functions. Though some analysts are developing open source Python and R toolboxes, there are still inherent technical knowledge barriers to implementation (Higgins 2019). Other accessibility tools have been developed, but are usually limited in geographic or analytic scope and have yet to bridge the "implementation gap" to use in practice (Papa et al. 2016; Stewart 2017b).

3.2.2 Transportation network input data

The aforementioned softwares require a slew of input data, and in the base case requires a network for the modes of interest and the locations of opportunities of interest (e.g. jobs). The most common form of network data for transit and automobile travel comes from travel time matrices between Traffic Analysis Zones commonly used for transportation demand modeling by metropolitan planning organizations (MPO's) (Levine et al. 2012; Shen 1998). These are convenient but limited in their geographic units of analysis and possibilities for testing new scenarios. Further, travel times are dependent on the unstandardized individual calculations by each MPO. Alternatively, analysts can create their own network from ESRI shapefiles in ArcView's Network Analyst, or can make use of well-developed open-source data.

OpenStreetMaps (OSM)[24] is a Wiki-style crowdsourced mapping project started in 2004 by Steve Coast at University College London (Haklay and Weber 2008). By now, it has amassed millions of contributors worldwide, with communities fostered mainly through mapping parties—where beginner and veteran mappers can get together, demonstrate use of GPS units and uploading data, and socialize. OSM is now a staple in mapping applications used by Facebook, Snapchat, Apple, and Uber, especially given its lower cost compared to other map tile data such as Google Maps. Humanitarian agencies[25] have made use of OSM following disasters such as the Haiti and Nepal earthquakes. Perhaps most impressive though is the coverage, where in 2017 OSM was estimated to be 83% complete with many developed countries with completely mapped road networks, more than datasets used by the World Bank (Barrington-Leigh and Millard-Ball 2017). The tool created in this thesis is deeply indebted to this effort.

Before 2005, someone visiting a new city would have to scour transit routes and schedules to plan a trip, far more difficult than using Google Maps, Mapquest, or Yahoo Maps for driving directions at the time. The General Transit Feed Specification (GTFS), first implementing Portland's (Oregon) TriMet into Google's Transit Planner in December 2005, was the first attempt at making transit data openly accessible to the public (McHugh 2013). The data standard was made as simple as possible, and now is published to the web by more than 2500 operators in over 55 countries.[26] GTFS has also inspired a slew of other mobility data standards, such as GTFS-RT for real-time transit data, GBFS for bikeshare, and MDS for micromobility. Without GTFS, transit accessibility analyses would be far more imprecise.

To bring open source road and transit data together, the next step in accessibility analysis is routing. For that, development for the multimodal OpenTripPlanner (OTP)[27] by TriMet and a coalition of transit software companies started in 2009, with an official v1.0 release in 2016. OTP was based on an open-source philosophy, with anybody able to run it on a laptop and a lively Google Group mailing list for support. OTP is the base of many accessibility visualizations, from public sector led efforts such as NYC Regional Plan Association's Access to Jobs tool[28] to the extensive and automated Accessibility Observatory at the University of Minnesota (Figure 3.3) (Owen and Levinson 2014). These efforts are major advances in openly available accessibility visualization, but only go as far as abstracted place-

[24] https://www.openstreetmap.org/
[25] E.g. Humanitarian OpenStreetMaps Team https://www.hotosm.org/
[26] https://www.transit.land/
[27] https://docs.opentripplanner.org/en/latest/History/
[28] https://lehd.ces.census.gov/doc/workshop/2014/Presentations/RPALED9.9.14Conference_FINAL.pdf

based opportunity measures and do not incorporate demographic and vehicle ownership information that can bridge accessibility metrics more meaningfully to lived experience.

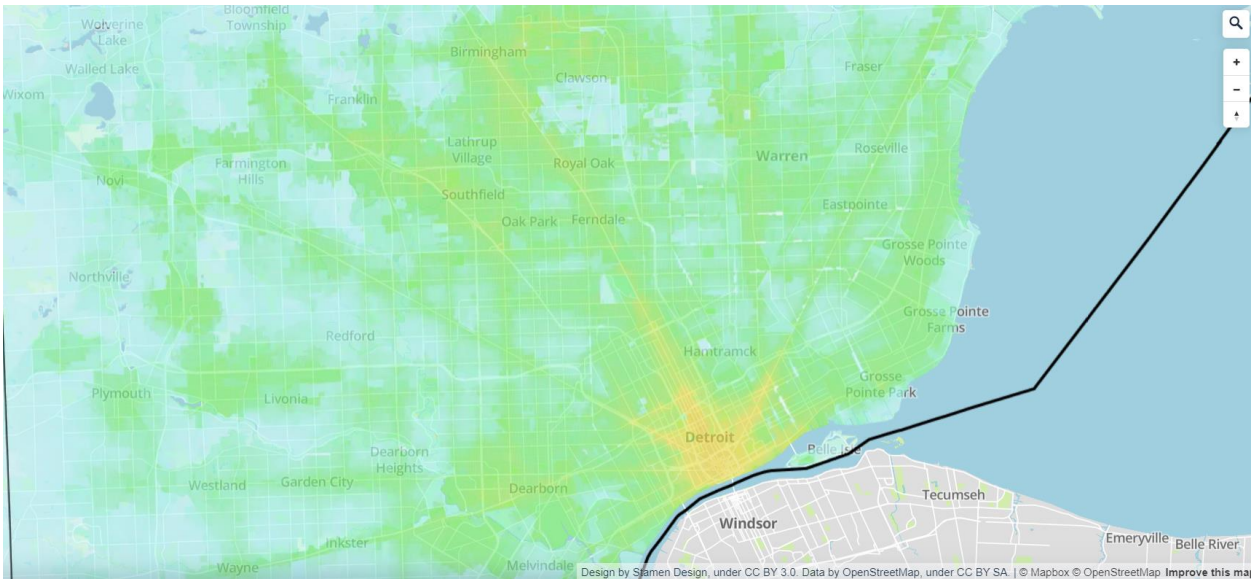

Figure 3.3 - Accessibility Observatory Transit Accessibility for Detroit in 2018.[29] This is a major comprehensive effort at accessibility analysis within the US, but lacks a user-friendly interface or easily explored insights.

Unfortunately, OTP is not computationally efficient for large scale regional analyses at detailed resolutions. Conveyal[30] is an independent consultancy branched from OTP's software team that created Rapid Realistic Routing on Real-world and Reimagined networks (R5) (Figure 3.4), combining work from OTP with algorithms from R4[31] (e.g. the RAPTOR pathfinding algorithm) for faster performance (Conway, Byrd, and van der Linden 2017). There are several notable advances that R5 makes, including the ability to compute different transit network scenarios quickly using commodity cloud services, the ability to compute accessibility at a high spatial resolutions as a raster, and introducing a statistical method for trip simulation (i.e "realistic"). Extensions have incorporated transit reliability and fare cost constraints within the route optimizer (Conway, Byrd, and van Eggermond 2018; Conway and Stewart 2019). Conveyal provides assistance to transit agencies in implementing their tool, generously provided an academic access license for this thesis, and recently released a regional accessibility analysis function in v5.10[32] that takes *minutes* to calculate the cumulative opportunity accessibility metrics used in this thesis for a whole region.

[29] http://access.umn.edu/research/america/transit/2018/maps/index.html
[30] https://www.conveyal.com/
[31] https://github.com/bliksemlabs/rrrr
[32] https://github.com/conveyal/analysis-backend

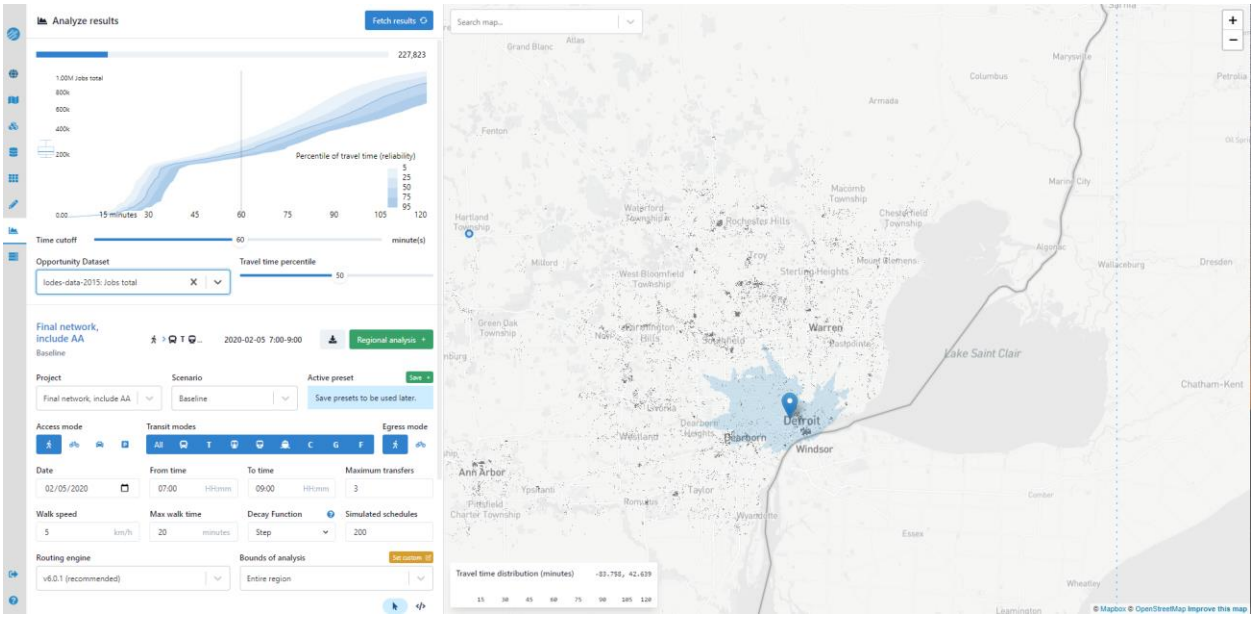

Figure 3.4 - Conveyal Analysis tool using R5

3.2.3 Web-based accessibility tools

Accessibility analyses generally start from isochrones, or the areas reachable from a chosen point by a given mode at a given time. These are intuitive and grounded representations of mobility, and are conveniently calculated along the way of shortest-path algorithms. Early examples used ArcView's Network Analyst to generate a handful of transit isochrones (O'Sullivan, Morrison, and Shearer 2000), but these were severely limited within noninteractive maps. Now, isochrone maps for transit[33] and automobile[34] modes are widespread all over the web and assisted by quick API's[35] (Schoedon et al. 2019).

Integrating isochrones with opportunity datasets yields cumulative accessibility metrics, and is a strategy used by some web-based accessibility tools. Páez et al. (2013) built a web-based accessibility calculator for the Greater Montreal area, where a user creates an individual profile and is returned a personalized map of nearby amenities given the user's average travel distance. This is a simple, but effective integration of isochrone and opportunity data. The prototype unfortunately did not include transit modes or more detailed shapes beyond circular buffers. Golub et al. (2013) created a demonstration web-based calculator for improved equity evaluation and public participation in regional transportation plans. Given the closed-off nature of Title VI equity analysis and lack of public participation in the process, they demonstrated an equity-oriented map-less application that showed the differences in accessibility to various neighborhoods and demographics caused by San Francisco's 2005 Regional Transportation Plan. Lastly, Yin et al. (2015) created an accessibility visualization application for the Metropolitan Chicago Area that showed accessibility metrics for individual block groups, with a slew of options for the analysis. This makes use of fairly modern techniques (e.g. GeoJSON input data, Leaflet,

[33] https://www.mapnificent.net/

[34] https://isoscope.martinvonlupin.de/ also includes walking isochrones.

[35] https://openrouteservice.org/, https://www.walkscore.com/, HERE API https://developer.here.com/. Full resources are listed here https://wiki.openstreetmap.org/wiki/Isochrone

Amazon EC2 for server hosting). Unfortunately, most of these tools have not scaled up and many are deprecated or off the web, given high hosting and maintenance costs.

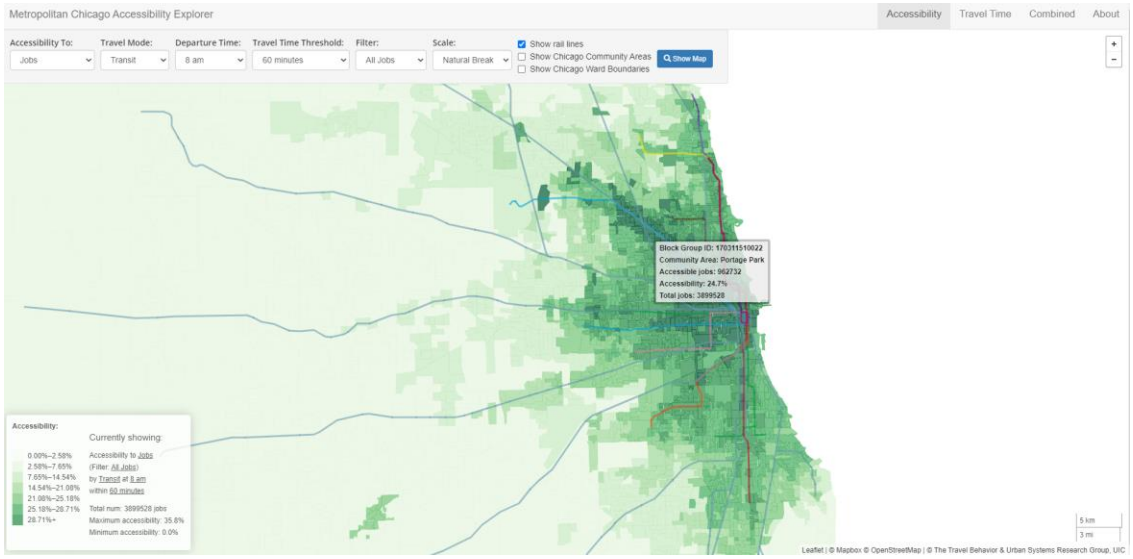

Figure 3.5 - Metropolitan Chicago Accessibility Explorer (http://urbanaccessibility.com/accessibility/)

Lastly, Conveyal's Analyst tool evolved concurrently with CoAXs, an open-source stakeholder-engagement tool developed at MIT to support co-creative transport planning (Stewart 2017a; 2017b; Stewart and Zegras 2016). It consists of a user interface with interactive visualizations, as well as a backend using Conveyal to make accessibility calculations for different scenarios. Starting from a tool for BRT projects (Stewart 2014), this has evolved and has been tested in workshops in Boston, Santiago, London, and Pretoria.[36] The tool was initially centered around workshops, following planning support systems literature, and coordinated with advocates, community-based organizations, and universities to facilitate social learning (e.g. Figure 3.6). Further iterations of the tool went "remote", without the workshop portion and interacting solely through a web application, but found lower levels of usability and inspiring imagination, mainly due to the lack of interpersonal communication. However, the reduced location and time constraints of the remote application allowed for much wider deployment, suggesting potential benefits of a hybrid approach (Zheng 2018).

Figure 3.6 - CoAXs BRT workshop in Boston using a touchtable interface in 2015

[36] http://coaxs.scripts.mit.edu/home/

3.2.4 Geospatial data visualization libraries

This thesis seeks to take advantage of the widespread mapping packages associated with the latest tech-driven age of slippy web maps and data visualization. A whole lot has changed, now with capabilities for smooth rendering of millions of datapoints on personal computers through the web browser. A summary of these efforts is seen below in Table 3.1.

Table 3.1 - Overview of Common Web Mapping Libraries

Google Maps	• Probably the most polished mapping library released around 2006. • Allows for most of Google Maps functionality— geocoding, directions, traffic services. • Not easily extensible with custom layers from external data sources. • After 2011, dramatically increased its premiums to its API service, prompting the creation of more sophisticated open-source tools (Zastrow 2015).
CartoDB	• Software-as-a-Service cloud computing platform initially released in 2011. • Easy usage for those without GIS experience— simply upload data to their interface and they handle all of the database storage and visualization. • Although open-source, the company's business model comes from high prices for data storage to use in conjunction with their web service, costing hundreds of dollars per month for only 500MB of storage, certainly prohibitive to everyday researchers (Zastrow 2015).
D3.js	• Created by Michael Bostock, former graphics editor for the NY Times, initially released in 2011. • Commonly used data visualization library for news media outlets that can be geared up with most of the out-of-the-box functionality of mapping-specific libraries. • High customizability trades off with steep learning curve and manually coding functionality.
Leaflet	• Lightweight open-source mapping library (38KB) released in 2011. • Most commonly used open-source mapping library, with highly customizable interactivity and layer control • Extensive documentation, plugins, and support. • Limited performance with large scale datasets.

TileMill, Mapbox.js, and Mapbox GL JS	• TileMill was a CSS-oriented geospatial data visualization tool released in 2011.
	  ○ Accessible to those without GIS familiarity, but highly customizable.
	  ○ Inexpensive and downloadable onto personal computers (Zastrow 2015). Now merged into Mapbox Studio.
	• Mapbox software directly stems from Leaflet, with many developers working on both libraries.
	• Mapbox.js was a plugin for Leaflet initially released in 2011 to display Mapbox raster map tiles.

	• Mapbox GL JS is the latest rendition of Mapbox's mapping library initially released in 2016, and utilizes an OpenGL framework (using WebGL) to offload rendering from the browser to a computer's GPU, allowing for high quality vector tiles. • Mapbox services generally require an API key with a generous free tier, though the mapping libraries are completely open source and easily used with other tiling services.
React	• React is an open-source frontend library for building user interfaces, maintained by Facebook and initially released in 2013. • Framework is based on components that *react* to changes in a "state" to allow for efficient re-rendering of the browser. • "Wrappers" take existing libraries and abstract them for easy usability in a React framework. Many have been created for open-source mapping libraries (e.g. react-leaflet, react-map-gl).
deck.gl	• Part of vis.gl, a visualization suite from Uber's data visualization team. • Initially released in 2015, deck.gl is a highly performant tool for 2D and 3D display of large datasets. • Much like other GIS frameworks, uses a layered approach. • Easily integrated with React, Mapbox GL, and Google Maps. • Heavily relies on GPU, which may not be very robust in many personal computers.

3.3 Creating the SE Michigan Accessibility Explorer

3.3.1 How is this tool different?

It would be foolish to recreate the plethora of work already done, but it is clear that accessibility tools have yet to be fully utilized in practice (Papa et al. 2016) and even less by the public. In SE Michigan, accessibility visualizations are mostly limited to academic papers and a handful of visualizations by SEMCOG following their Access to Core Services study (SEMCOG 2016).[37]

Given the high maintenance and support needs of many web-based tools, this tool aims to be structured simply and documented well to be able to troubleshoot. In this, unlike CoAXs, which embodies many similar goals, this tool will not allow for two-way communication between an analysis server and a front-end client, but rather will operate off of a precomputed database. Knowledge co-creation will be facilitated more simply through feedback forms and iterations to make the tool as useful as possible. Given the goal of promoting awareness of spatial injustices as opposed to proposing new transit route plans, a true back-end analysis server would overcomplicate the tool.

In general, this tool seeks to push new representations of space and accessibility for an everyday public that usually relies on personal anecdote. As mentioned in interviews with SE Michigan transit planners, the mere act of showing maps of the region, inevitably highlighting Detroit's centrality, makes some stakeholders in suburban municipalities uneasy. Regional representations can help build a regional understanding of and vision for accessibility—one of the major noted barriers to transportation reform.

[37] https://www.semcog.org/map-gallery

This tool also differs from others in its focus on connecting “place” and “people” accessibility, particularly with an eye towards race. This jump makes the link from uneven accessibility to social justice outcomes explicit, something that existing tools fail to do. When they try, as in Golub et al.’s (2013) accessibility tool, the results are far below today’s standards of interpretability.

Lastly, given the quick evolution of new mapping and user interface libraries for the web, this tool seeks to use the latest technology and computing capabilities to visualize accessibility to a more detailed spatial resolution, to address the Modifiable Areal Unit Problem (i.e. arbitrariness of aggregation geometries) (Openshaw 1984). In using these open-source libraries, it hopes to add to the open-source knowledge base with clear documentation of the creation process, for a tool that is hopefully useful.

3.3.2 Building the tool

Building the tool (https://accessmichigan.mit.edu/) followed the following workflow (Figure 3.7):

1. Collect network data from the region’s GTFS (from transit agencies or the Transitland database) and OpenStreetMaps. Collect job opportunities datasets from the US Census’ LEHD Origin-Destination Employment Statistics (LODES), downloaded through the R package `lehdr`. Collect population datasets from US Census American Community Survey (ACS), downloaded through the R package `tidycensus`. Spatial data manipulation done using `tidyr` and `sf` frameworks.
2. Set up and run a local or cloud-based Conveyal Analysis instance and calculate an “access to population” raster to normalize each job location by in the competitive accessibility metric. Do this for car/transit, and low-income/all population configurations. Conveyal’s cloud-based tool is the same as running locally, but uses AWS EC2 instances to scale up large calculations, and requires a license.
3. Create adjusted job opportunity rasters by normalizing by access to population raster in R.
4. Rerun Conveyal Analysis to calculate final competitive access to jobs rasters for all configurations.
5. Assign accessibility values to a simulated population using ACS demographic and vehicle ownership data in R and QGIS, which uses some faster Python algorithms.
6. Export dot density maps for all configurations to Mapbox tilesets, a compressed and easily displayed data format, using `tippecanoe`.
7. Upload to Mapbox tileset hosting via the Uploads API.
8. Create a front-end module in React.js using Mapbox GL JS, Chakra UI, and other libraries to display accessibility results with open-ended exploration.
9. Deploy to the web via Heroku, a “platform as a service” company that allows for scalable deployment of web applications. Can create custom domain name via multiple online hosting services.

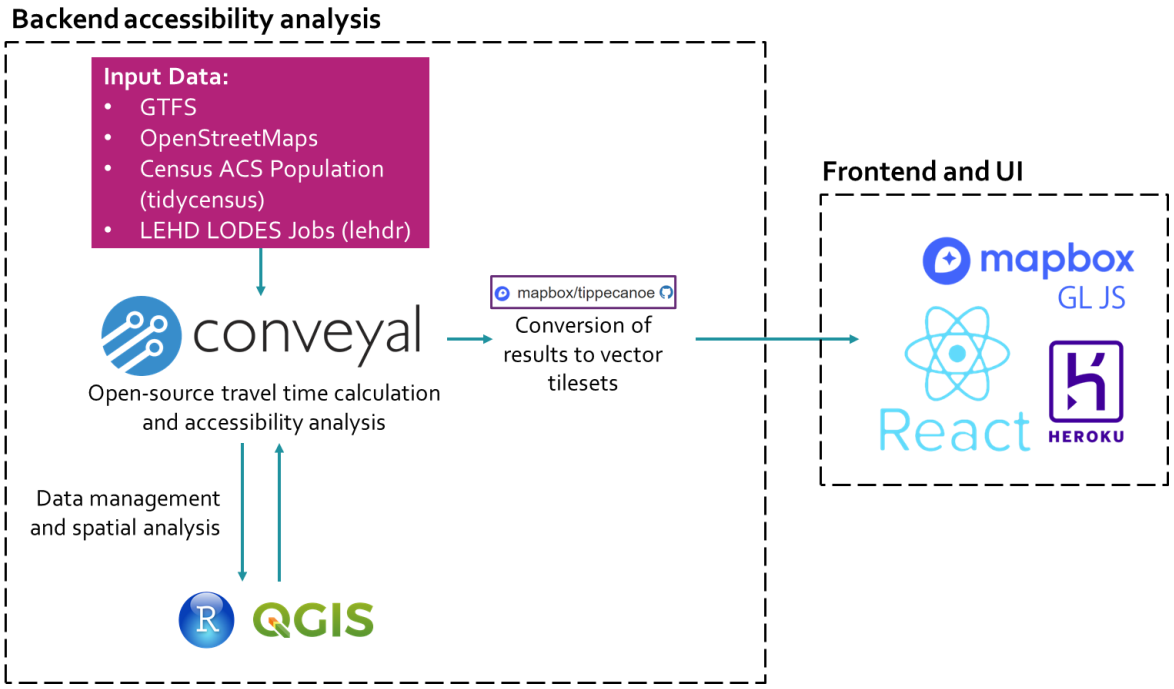

Figure 3.7 - Tool building workflow

A full technical documentation a details of the accessibility calculation is outlined in a Github repository.[38] As with any project of this nature, the final product and workflow is a lot simpler in hindsight—each step included an exploration of alternatives, lines of code and frameworks that were much messier than necessary, but also useful lessons for those who wish to tread a similar path, and an update to data and findings from SE Michigan.

3.4 Accessibility Findings

The main purpose of the tool is to amplify community voices, though the influence of the tool builder is inevitable and should not be obscured. This section outlines my own accessibility analysis adding to existing SE Michigan accessibility analyses in the literature.

3.4.1 Existing literature on accessibility in SE Michigan

SE Michigan is a stark illustration of spatial mismatch within US cities, with a growing share of metropolitan jobs in the suburbs while Black people have been confined to the urban core through decades redlining, restrictive covenants, and informal racism, among other racist policies (Hackworth 2019). Federal highway construction fed industrial growth in nonurban areas while razing densely populated Black communities such as Paradise Valley (Sugrue 1996). Employers have a history of racial discrimination occluded by transportation policy, and at one point when asked why they oppose a van service for low income workers, most indicated they did not want to hire Black workers, one employer saying, “Why do you think we moved out here in the first place?” (quoted in Turner 1997).

Despite this, the city’s geographic centrality and concentration of Black and low-income people, coupled with a radially oriented transportation system, should theoretically facilitate greater access to jobs for

[38] https://github.com/kxshen/semi-accessibility-explorer

disadvantaged groups in the city. With greater diversification of inner ring suburbs and the reconfiguration of existing color lines[39], perhaps this geographic benefit would dominate. Unfortunately, commuting between the suburbs and the city is increasingly asymmetrical, with Detroiters commuting out of the city often for service sector jobs, while suburbanites take advantage of the concentrated job opportunities in downtown (Holzer and Rivera 2019; Glynn, Shen, and Goetz 2020).

Accessibility analyses of the region have made different methodological choices but have landed on similar conclusions. Allard and Danziger (2002) used a simplified competitive job accessibility measure with Euclidian distance in the impedance function to find that job access is a statistical determinant of reported work earnings and welfare exits. Some have highlighted that accessibility measures can more accurately represent lived experience through breaking down populations by demographics, travel by mode, and employment opportunities by occupations (Li 2012, 16). This thesis can be taken as an extension of Grengs (2010; 2012), which improved upon past studies by estimating gravity-based job accessibility taking into account modal differences between automobiles and transit, using the 2000 CTPP at the TAZ level in Detroit. The studies broke down job accessibility differences between groups based on race, income, and vehicle ownership, and found that the inner-city is advantaged by its geographic position and but disadvantaged by low car ownership, especially for Black people. Grengs dubbed the resultant disparity between automobile and transit accessibility the "modal mismatch".

SEMCOG has created maps with roughly the same geographic distribution of job accessibility, but separates its analyses of transit and auto accessibility. Though recommendations from this analysis are numerous, they generally lack specificity and are not actionable, as is the situation in many MPOs (Karner and Niemeier 2013). A comparison between these accessibility analyses in Figure 3.8 shows that the conclusions are quite similar.

[39] http://www.dailydetroit.com/2017/05/04/new-maps-show-20-years-racial-change-metro-detroit-sharp-detail/

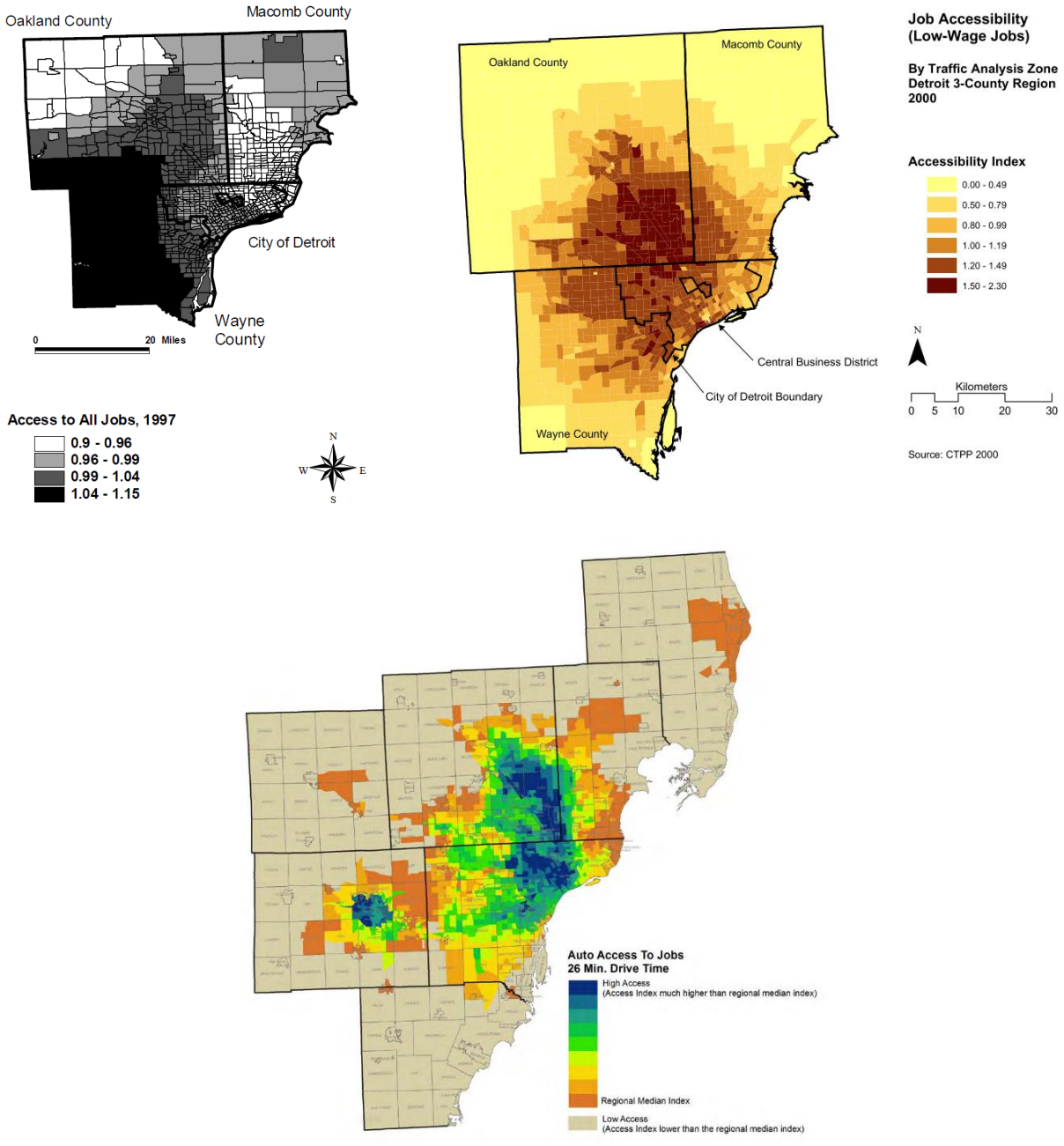

Figure 3.8 - Existing accessibility analyses identify similar geographic distributions. Allard and Danziger (2002) *identify high accessibility in western Wayne and southeast Oakland counties, but relies on outdated data (top-left). Grengs* (2010) *identifies high accessibility in the city of Detroit, but the highest concentration of mode-weighted accessibility in southwest Oakland county (top-right). Lastly, SEMCOG* (2016) *outlines similar concentrations of accessibility in 2016, with much more prominence in Detroit without weighting by mode (bottom).*

3.4.2 Updated accessibility analysis results

The tool developed in this thesis allows for an update of these previous studies to 2017-2018 demographic and job data and 2020 transportation networks. Transit networks have become slightly more robust following the recession recovery, and the GTFS data used is representative of pre-pandemic

service in January 2020. Though these patterns are not expected to affect much in the accessibility analysis, it is practically useful to have an updated analysis as well as a demonstration of the web tool.

Instead of dividing the region into arbitrary geographic units, one major difference of the accessibility explorer is the use of dot density maps, with each dot roughly representing a person 16 and over. Differences in accessibility are smoothed out among dots rather than spanning jagged blocks, much more reflective of the actual transportation network. Dot density maps rely on raster accessibility calculations, something relatively new and technically enabled by Conveyal. Given the academically fruitful case study of SE Michigan, the analyses are limited to the four-county region defined as Wayne, Oakland, Washtenaw, and Macomb counties.

3.4.2.1 Place-based analysis

Snapshots from the web tool (Figure 3.9) show the distribution of competitive job accessibility, akin to the maps in Figure 3.8. Generally, the distribution is similar, with a peak around the inner ring suburbs of Oakland county (Southfield, Royal Oak, Ferndale). These areas have access to the job cluster in downtown Detroit as well as geographic centrality among the multiple job centers in the inner ring suburbs. Because the competition normalization methodology conservatively assumed all people within 60 minutes of a job are "competing" for it, job centers in downtown Detroit or in Ann Arbor lost their access advantage. Though the average commute time in the region is around 30 minutes and people might not be participating in the labor market so robustly 60 minutes away, this choice highlights the functioning of the metro area as a regional labor market, especially for those who own a car.

As noted in Grengs (2010), the disparities between access for those using the full road network and those relying on the region's sparse transit service far outweighs geographic factors. The bottom panel of Figure 3.9 shows that job accessibility via transit, which even with a doubled travel time cutoff, is on lower order of magnitude than job accessibility via automobile. Though transit routes do reach many parts of the city, headways can go up to every hour, rendering many routes marginally useful. Significant increases can be seen on Woodward, Gratiot, Grand River, Michigan, and 7 Mile, which are corridors with major service improvements including ConnectTen 24/7 routes and FAST high-frequency express service. Though transit accessibility is still much lower than auto accessibility, these routes have offered meaningful accessibility improvements.

Though many accessibility studies would use a weighted average of transit and automobile accessibility in their place-based analyses (e.g. Shen 1998), doing so creates an imaginary accessibility value that nobody actually experiences (Grengs 2012), and even more insidiously obscures the stark side-by-side inequities of people with extremely high and extremely low job accessibility. In assigning accessibility metrics to each person, I assume that any household without a vehicle is dependent on transit, and I conservatively assume that households with at least one vehicle experience automobile accessibility.

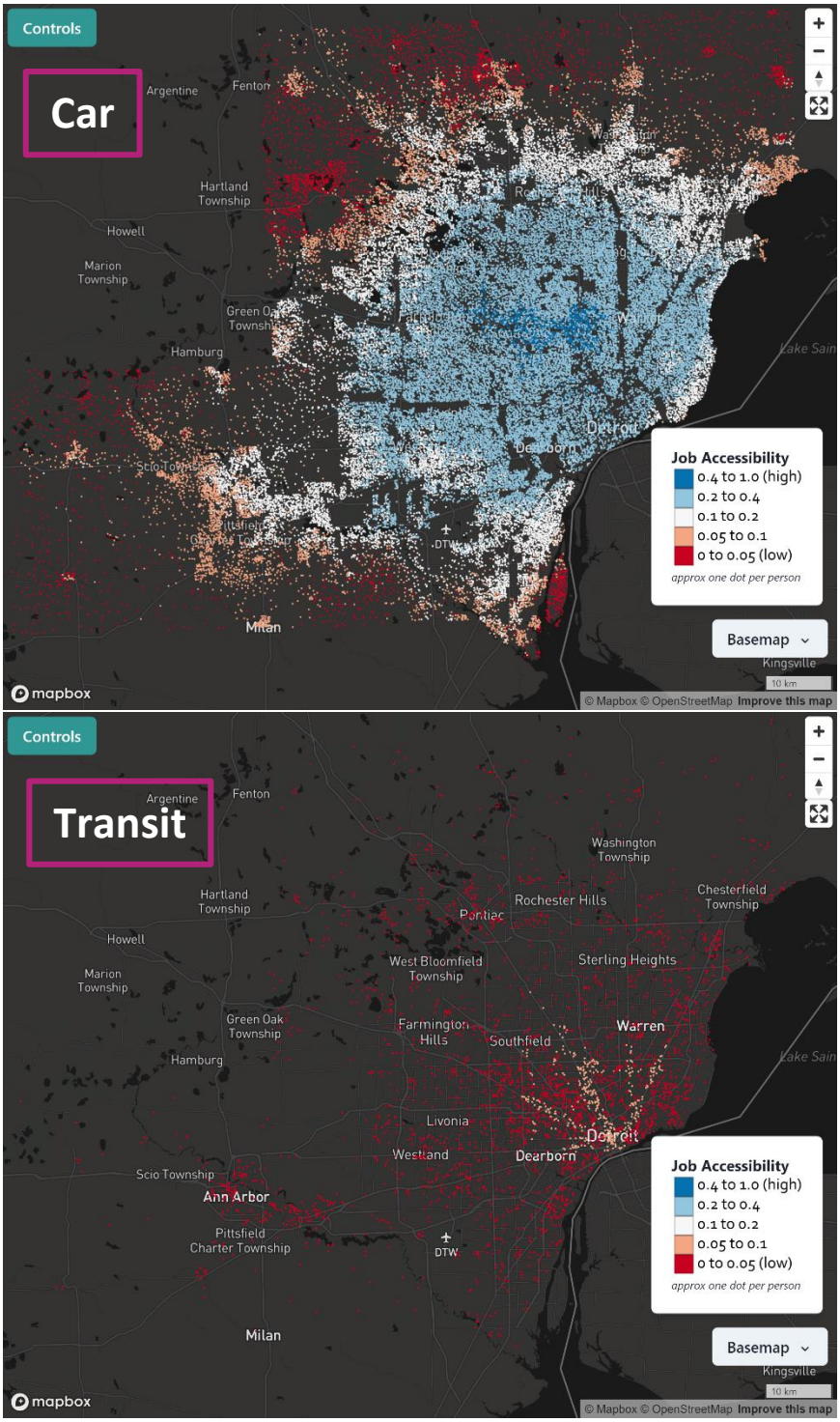

Figure 3.9 - Updated accessibility distributions to all jobs: car accessibility within 30 minutes (top); and transit accessibility within 60 minutes (bottom). Different travel time cutoffs selected to highlight differences. See https://accessmichigan.mit.edu/.

3.4.2.2 Equity analysis by race

People-based measures of accessibility are more representative of lived experience, and can lead to effective equity analyses. Figure 3.10 compares accessibility to jobs for both Black and non-Black populations and illustrates a couple of points (Grengs 2012). First, the pronounced 'S' shape of the

curves for the Black population means that they either experience low or high accessibility, varying mostly due to vehicle ownership. The smoother curves for non-Black and White populations means that accessibility is more evenly spread amongst them, mostly varying due to geography. Second, on average, Black people have higher accessibility than non-Black people. To that I would argue that lived differences in high accessibility values, the difference between being able to reach some versus many jobs, are not as important for equity as differences in low accessibility values, the difference between being able to reach a handful versus some jobs.[40] Lastly, the extreme disadvantage for the 17% of the region's Black people without a vehicle is much larger than the 6% of non-Black people.

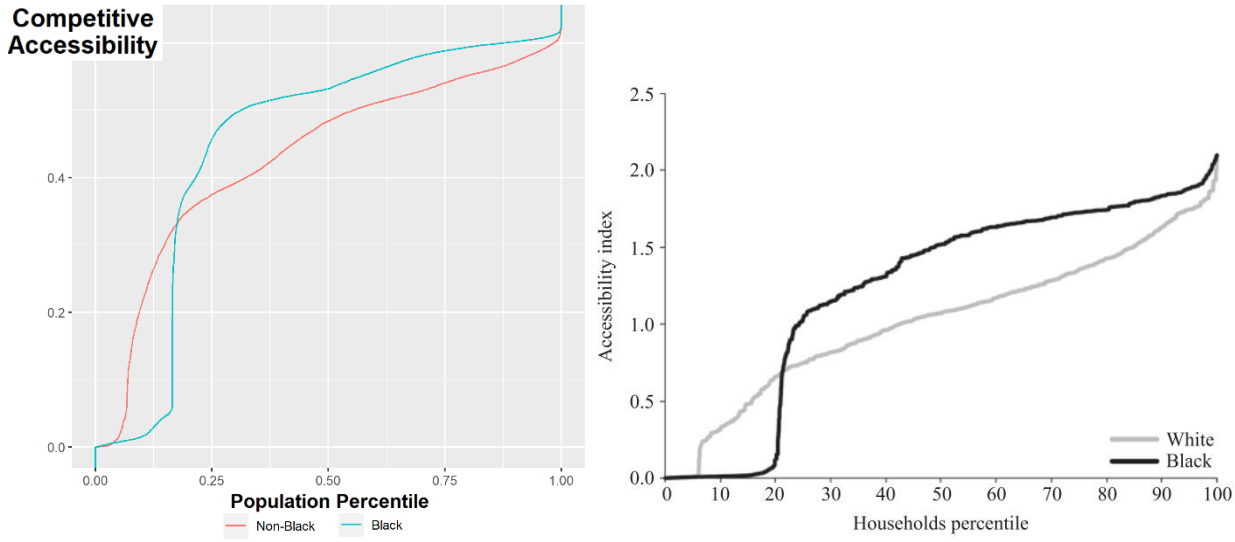

Figure 3.10 - Updated cumulative distribution function of accessibility for Black and non-Black populations in the four-county region with a 45 min cutoff in 2018 (left) compared with a similar graph of the three-county region in 2000 in Grengs (2012) *(right). Accessibility indices are different due to methodologies but should be internally consistent to each figure.*

Figure 3.11 mixes together all people, both those who experience automobile and transit accessibility, and then shows accessibility distributions filtered by Black and non-Black populations. Immediately one can see the concentration of Black people with low accessibility in the city of Detroit. This is due to the spatial coincidence of race and car ownership rates—Detroit is both 78% Black and 25% no-vehicle households, whereas the region is 23% Black and 9% no-vehicle households.[41]

[40] A quick note on interpretation of the competitive accessibility value. The measure can be roughly interpreted as "jobs per person 16 and over". The region has around 1.9M employed people (LODES), and 3.4M people 16 and over, so the median accessibility value for the region under a 60 min cutoff should be 0.56. The median accessibility value for the 45 min cutoff in Figure 3.10 is 0.50. I argue that with an eye towards equity, the people on the left side of the graphs require more attention.

[41] Data taken from American Community Survey 2014-2018 5-Year Estimates.

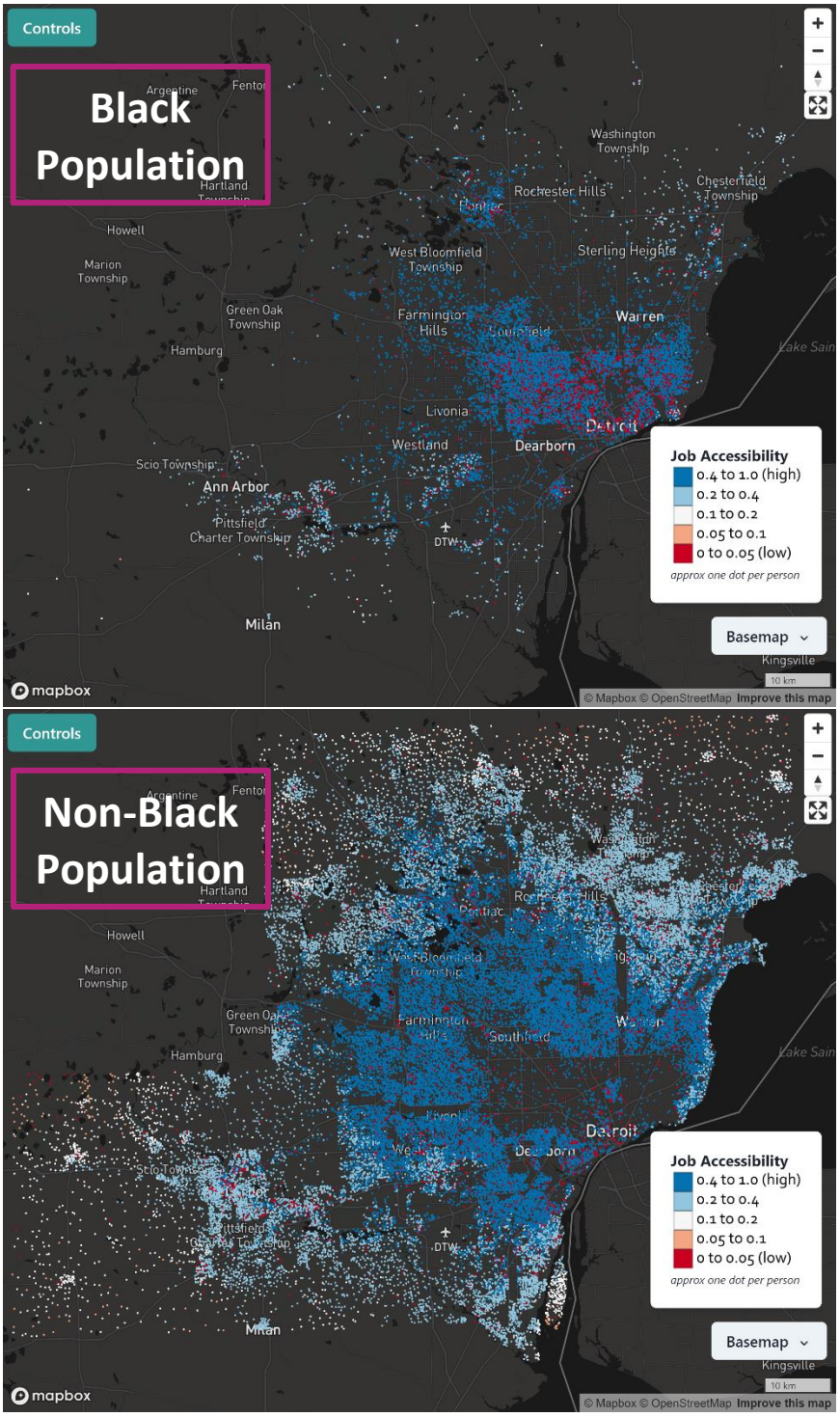

Figure 3.11 - Accessibility to all jobs by race. Both panels using 45 min cutoff to highlight differences.

These accessibility metrics solely measure the effects of the physical transportation network and car ownership, but leave out the role of transportation within a criminal justice system that targets poor and Black people. Many in SE Michigan drive illegally due to high barriers to automobile access such as high insurance rates, high costs of car ownership, non-driving reasons for license suspension, and

excessively harsh misdemeanors and civil infractions (Chowning, Keith, and Leonard 2020; Glynn, Shen, and Goetz 2020). Traffic stops for small things (e.g. busted taillight) can easily lead vulnerable drivers into a vicious cycle of job loss, arrest, and incarceration leading them deeper into the criminal justice system. At worst, transportation has been implicated in nationwide police brutality—over a quarter of police killings of unarmed Black people in the US since 2015 occurred at traffic stops.[42] Accessibility metrics do not account for these real barriers impeding to the "ease of getting to jobs", and focus on the material transportation system. Still, pointing out racial injustices in both contexts can be complementary and lead to multiple routes to more just outcomes.

3.4.2.3 Income

Similarly, Figure 3.12 compares accessibility to jobs for low income (<$40,000/year) versus high income (>$40,000/year) people. Those who are not in labor force (NILF) or unemployed are considered low income. No-vehicle households were assumed to be low-income people before any assignment to high-income people, and so this analysis assumes close to no high-income people dependent on transit. The similar 'S' shape is more prominent for low-income populations, again a testament to the modal mismatch, but this time the curves never cross. This means significantly lower accessibility for low-income people generally.

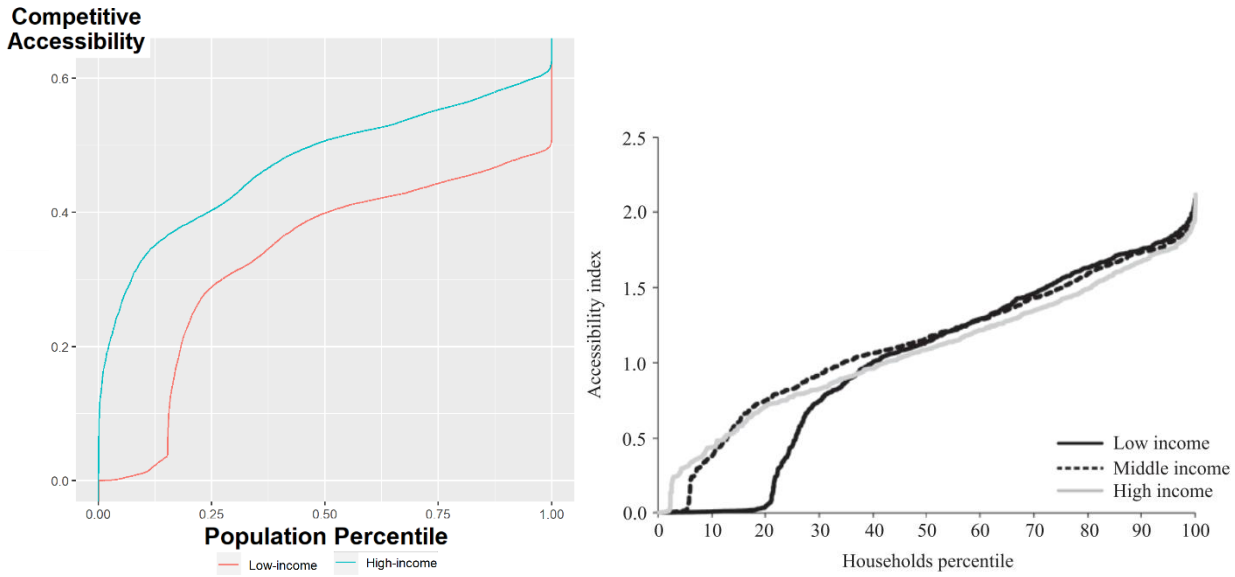

Figure 3.12 - Updated cumulative distribution function of accessibility for low income and high income populations in the four-county region with a 45 min cutoff in 2018 (left) compared with a similar graph of the three-county region in 2000 in Grengs (2012) (right)

Lastly, Figure 3.13 shows accessibility differences by income spatially. Unlike the race comparisons, people of both income categories live across the region, though with some concentrated pockets such as a denser low-income population in Detroit. The red dots spread across the region show how low accessibility is a problem throughout the region, though especially within Detroit.

[42] Cheryl W. Thompson. "Fatal Police Shootings Of Unarmed Black People Reveal Troubling Patterns". *NPR*. Jan. 25, 2021. https://www.npr.org/2021/01/25/956177021/fatal-police-shootings-of-unarmed-black-people-reveal-troubling-patterns.

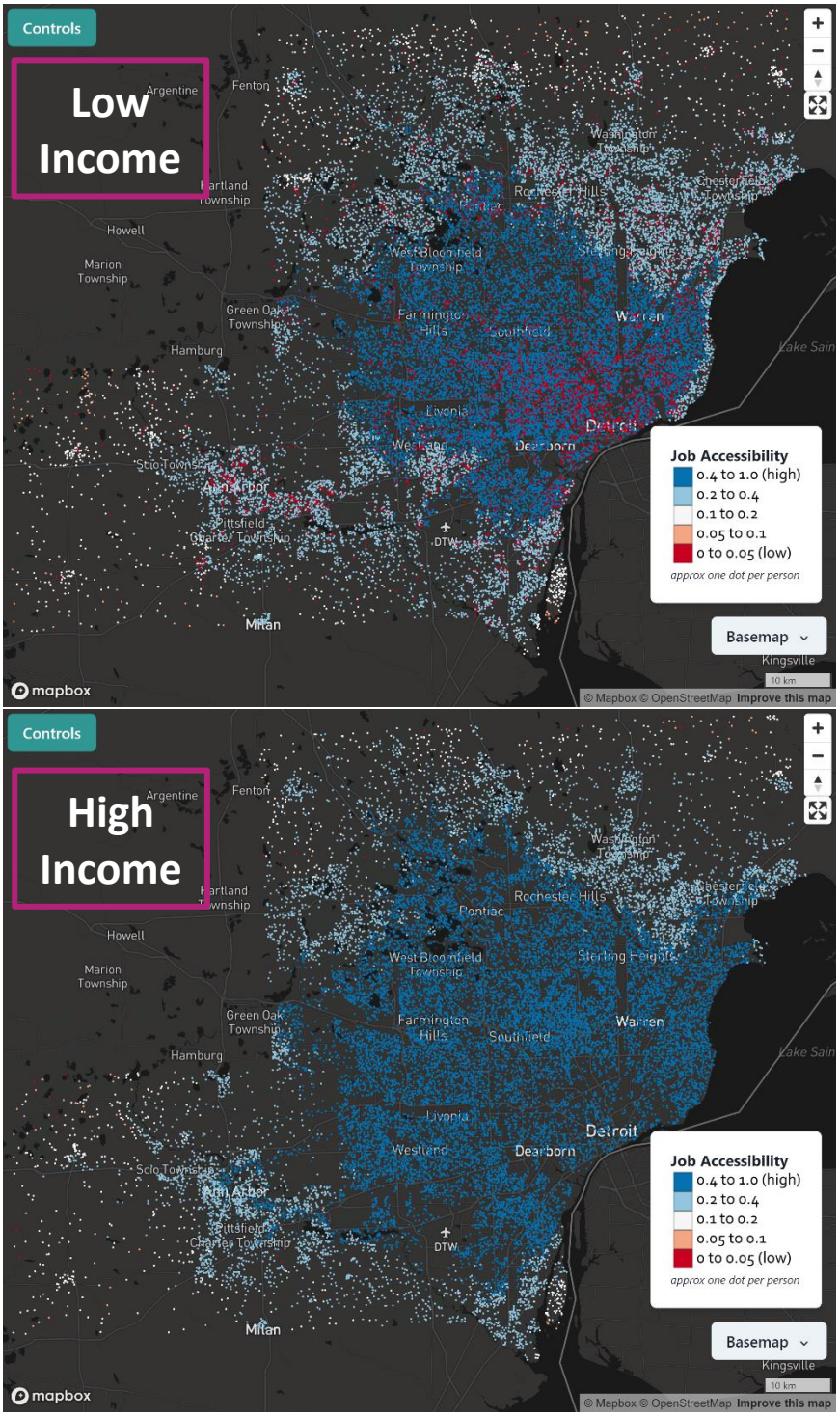

Figure 3.13 - Accessibility to all jobs by income

3.4.2.4 Accessibility calculation settings

Accessibility scholars also emphasize methodological innovation in accessibility calculations. The competitive accessibility metric makes a sizable difference in matching lived experience (Merlin and Hu 2017), but others have advocated distinguishing between peak and off-peak transit schedules (Stacy et

al. 2020) or between different travel time percentiles (Conway, Byrd, and van Eggermond 2018). Travel time percentile accounts for the fact that not all trips are made in the median allotted travel time, and some trips might vary much more and require people to plan for travel times longer than the mean. For example, if a bus comes infrequently but gets to the destination quickly, a bus rider might account for more of the wait time when planning a trip. This study found that these differences are too subtle for regional scale equity analyses, but are important to keep track of. For more granular transit route design applications (as is Conveyal's main line of work), these small adjustments in calculation settings can make a larger difference. Lastly, it's worth pointing out that though peak-services are assumed in many transit accessibility studies, the odd shift times of more disadvantaged workers means that off-peak service might be more representative of lived experiences. The visual differences between these maps is subtle, but service type is still an important consideration.

3.5 Tool functionality

The functionality of the web tool goes beyond any intended use or the accessibility analysis above. This section will take a brief tour of the tool's functionality and then will end with an initial round of feedback from academia, practitioners, advocates, and the public, along with charting potential future work.

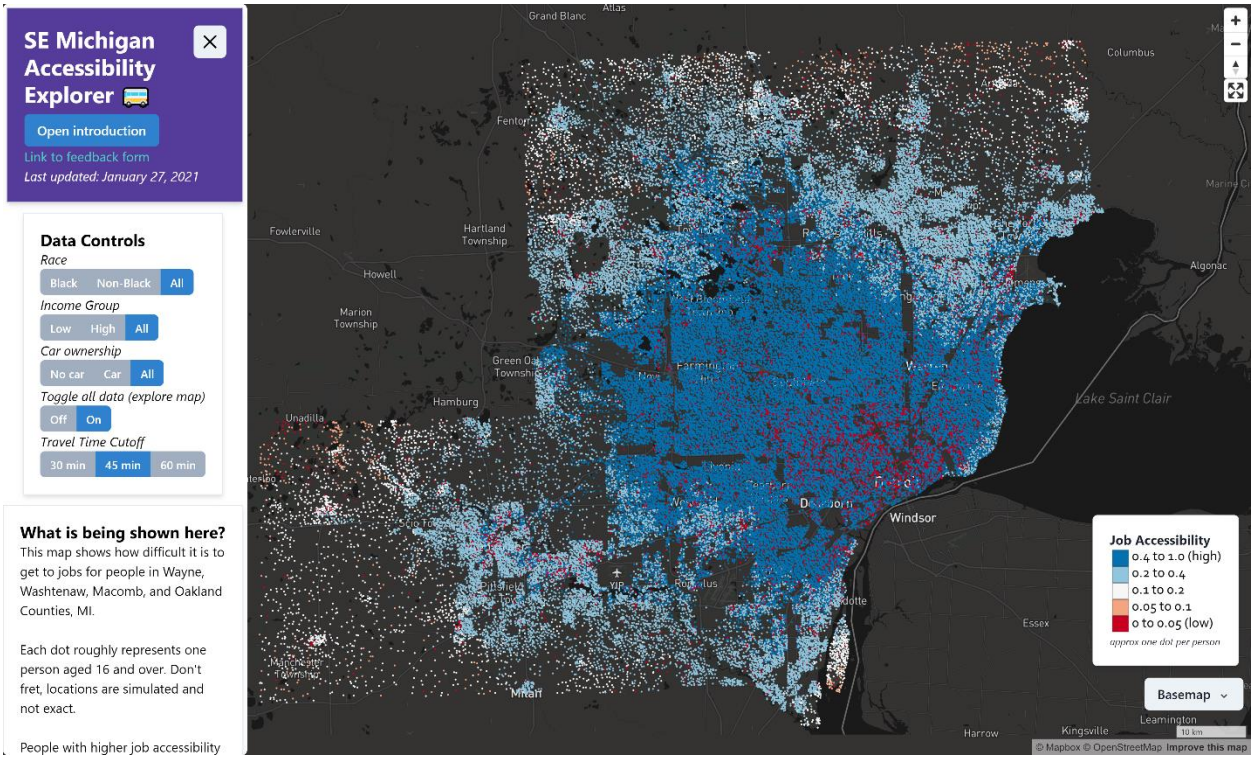

Figure 3.14 - Accessibility tool user interface upon opening https://accessmichigan.mit.edu/

3.5.1 Functionality

Figure 3.14 shows the user interface upon opening the web tool. It aims to be simple, interpretable, and visually appealing. After a welcome modal introducing the tool, users are able to pan, zoom, and rotate the dot density map built with Mapbox GL JS. A basemap menu in the bottom right allows the user to change the background map as well as show interstates and transit routes, major orienting landmarks.

Mapbox GL JS's navigation is similar to Google or Apple Maps, common map interfaces being used by the public.

On the left of Figure 3.14 is a toggleable and scrollable control panel with data toggles, explanation, and important links. First, users are able to toggle and filter the data by race, income group, and car ownership status. These simple toggles allow for users to explore the spatial correlations of different variables, and zoom in on different areas of interest. Users also have the option of toggling all data off to explore the map without the overwhelming dots. Accessibility calculation settings are also able to be toggled, with travel time cutoff as the most important, and transit service type (peak/off-peak) and travel time percentile relegated to a menu further down in the control panel.

The explanations aim to clarify what each dot and their color means, without getting too prescriptive of interpretation or technical in the methodology. Lastly, the panel links to the Github repository, this thesis, and a feedback form for subsequent iterations in future work.

3.5.2 Feedback

A small number of academics, practitioners, advocates, community members who gave an initial round of feedback all praise the look and feel of the tool. One commenter noted: "The look of the tool is impressive -- inviting and gives confidence that it's well done". Another mentioned that it was well presented for public consumption.

Being able to toggle data smoothly was also helpful and led to simple insights. Beyond this, interpretability was still a major barrier, despite my best efforts. Some noted that the value of the accessibility index was confusing. The "jobs per person" interpretation is alarmingly low without significant explanation of how it relates to labor force participation and unemployment rates. For low accessibility transit riders, less than 0.05 "jobs per person" could have an excessively deterministic interpretation (i.e. that transit riders can never get a job) without more context behind the number. Future accessibility analyses could consider using less conservative accessibility metrics for this reason.

Interpretability was also hindered by the sole reliance on quantitative and spatial data visualization. A dot density map already requires jumping through interpretative hoops that are taken for granted by academia and practitioners. One commenter not so familiar with transportation practice suggested small anecdotal pins or notes to give more context to the data.

A more abstracted source of feedback is through website traffic tracking and reporting, done through Google Analytics. Doing so reveals that at least 16 "users" have used the tool in Jan 2021, 6 logging on from SE Michigan, with an average session duration around four minutes. Though these tools are highly developed and useful in the web marketing industry, written feedback from users is much more useful for a collaborative tool.

In short, though the tool is far from overturning dominant representations of space, the welcoming user interface and piecemeal insights are meaningful contributions to the debate in SE Michigan. In the right hands, such as RTA staff during their long-range planning process for the 2022 ballot initiative, the tool can start to push meaningful change.

3.5.3 Reflections on the tool creation process

The goal of open replicability of the tool for different places and contexts requires some reflection on the whole process of the tool's creation. All of the software and knowledge used was open source or

made use of generous free tiers of existing services. Most of the software was well documented with examples and tutorials readily available. Even with this though, making use of these resources and putting them together in a useful way required massive amounts of time. Roadblocks often arose with libraries that are in the beginnings of development or without robust communities (e.g. Chakra UI). Being surrounded by a community that is familiar with libraries and methods was extremely beneficial in fast-tracking this tool, though these communities can be rare. Going through this journey once and documenting it can be helpful for those who wish to follow suit.

On the transportation side, GTFS data is not always publicly available, and for this thesis I had to leverage existing networks to obtain it. Further, much of the literature on accessibility and transportation planning are esoterically written or hidden behind publisher paywalls. Though these barriers can be crossed for those without a professional training in transportation, they indeed can be prohibitive.

Lastly, a lesson from Chapter 5 is that outreach and marketing is a substantial piece of work with a large ramp up period. Getting the small amount of users of this tool to take a look already took great efforts and leveraging a network of contacts in the region. Robust iteration will likely require the help of existing transportation advocates who see the potential in the tool's future and have the capacity to push outreach forward.

3.5.4 Future work

The tool is now in its first official publicizable version, and will face subsequent iterations depending on its reception. A few ideas for improvements have already arisen from initial feedback, and other tweaks can be done in the future if considered useful. First, adding opportunities for anecdotes and textual context can make the tool much more interpretable and impactful. This could be from a selection of known stories from transportation advocates, or could even be inputted by users and shown and a mode of discussion can be made using database tools like MongoDB. Second, additional explanation and a walkthrough page can help clarify even further what the data means for those willing to read it. Third, a concerted publicization push is necessary to truly test this tool's capabilities with the public beyond my own direct contacts. The initial version suggested the potential of the tool, and subsequent iterations may realize it.

On the academic front, it may be useful to dig deeper into the accessibility measures. The current conception of competition does not divide between different jobs sectors, which can lead to useful insights for workforce development actors. It may also be useful to look at nonwork accessibility, as over 75% of US trips in 2009 were made for nonwork purposes (Grengs 2015). Nonwork accessibility also highlights the often-neglected gendered nature of transportation, where women take on more varied responsibilities than men, including economically imperative but undervalued caregiving and housework, which results in more complex daily life and an increase in trip-chaining blending work and non-work trips (McGuckin and Murakami 1999; Scheiner and Holz-Rau 2017; Fernando and Porter 2002).

3.6 Conclusion

In seeking to create a collaborative accessibility tool, this thesis accomplished multiple things. First, it experimented with collaborative processes in mostly insular transportation planning. Second, it updated existing regional accessibility analyses with 2018 data and without arbitrary choice of geographic units. Lastly, it explored the possibilities of newly available open-source software in creating a tool that is approachable and interpretable to community members.

Acknowledging the small amount of community feedback thus far, the accessibility analysis already outlines a couple of key lessons for the region:

1. **The spatial distribution of accessibility in the region outlines long-known racial and economic justices— particularly the lower accessibility for Black and low-income people, concentrated in the city of Detroit**. Though the region's spatial demographics have been changing recently, the distribution of accessibility has not changed much since previous studies using 2000 data.
2. **The extreme inequality in accessibility outcomes is concentrated in the city of Detroit, but is indeed a regional issue, not limited to one-off anecdotes that often capture headlines**. Buying or subsidizing cars for people experiencing low accessibility can be helpful, but comes with many caveats and hidden costs of ownership. The widespread low accessibility indicates the need to "mount programs on a scale equal to the dimension of the problems".
3. **Increased bread-and-butter transit service can start to address this inequality at a regional scale.** Existing service improvements such as refleX/FAST corridors or the frequent 24/7 ConnectTen DDOT routes have made meaningful improvements to accessibility. Future transit improvements, particularly increasing frequency, can have network effects that lead to increasing returns on investment.

Through building the tool, some meaningful lessons for the transportation planning process also arose:

4. **Resources needed for accessibility analysis and visualization are widely available, but open source documentation is incredibly important for reducing barriers for others in the future**. Usefully putting together public data, open source analysis tools, and generous free tiers for web development requires the aid of a robust online community of accessibility experts and plenty of time and willingness to learn.
5. **Outreach and publicization of a web tool are a substantial piece of work and can dictate success.** With a reminder that transit is *not* a salient issue for the average SE Michigan resident, extra work is needed in highlighting what is at stake and why it is important.
6. **A well-done user interface with clear presentation of information is helpful in breaking down barriers between experts and the public.** New software has largely enabled the easily implementation of user-friendly designs. These have the potential to draw new attention and change the discourse towards mobility justice.

Chapter 4: Theories of Urban Experimentation

Urban experimentation[43] has become an increasingly dominant practice, yet is an inherently nebulous concept (Savini and Bertolini 2019). As a unit of analysis, urban experimentation draws a focus on "how particular urban infrastructure regimes are established, maintained and challenged" (Bulkeley, Castán Broto, and Maassen 2014, 1477), in essence how urban change "takes place" (Evans, Karvonen, and Raven 2016b, 4). This thesis seeks to clarify some key features through the following definition, informed by literature in sociotechnical transitions and geography (Claudel 2020, 9; Evans, Karvonen, and Raven 2016a; Savini and Bertolini 2019):

Table 4.1 - Defining Urban Experimentation

Defining Features	Commentary
1. *Intentional intervention in the urban environment*	Essentially, the definition of "planning" from Chapter 1. The "urban environment" implies a multi-actor public realm.
2. *Explicitly limited in scale— in space and/or time*	The absolute size of scale is not as important as its explicit limitation (e.g. existence experimental *cities* and urban laboratories included in Spilhaus (1967) or Karvonen and van Heur (2014)). This contrasts with a general or open-market "deployment" that gestures towards permanence (Urbanism Next Center 2020, 9), such as routine bus route service changes or the complete efforts of Uber and Lyft fueled by venture capital dreams of their ubiquity in the future.
3. *Challenges the status quo*	Experimentation can be taken as a method towards searching "for alternative ways to organise, plan, manage, and live in cities" (Evans, Karvonen, and Raven 2016b, 1). This "disruption" can be concretely physical/material, social, regulatory, etc.
4. *Claims of learning*	Challenging the status quo inevitably leads to uncertainty, and experimentation emphasizes producing knowledge from real-world intervention. Though, knowledge production is inherently political and can be further coopted by powerful actors during performative experiments.
5. *Actuality*	Actuality is in contrast with posturing at potentiality (e.g. vision-making). This feature makes useful the fact that "Urban experiments are intriguing because they constitute explicit attempts to stage and learn about different possible futures in the real world" (Evans, Karvonen, and Raven 2016b, 9).

[43] A quick etymological journey: *Experimentation* has roots in the Latin *experimentum* ("experience, attempt, experiment", which comes from *experior* ("to experience, to attempt"), which breaks down into *ex* ("out") and the perfect active participle of *perior* ("I go through"), with the Proto-Indo-European root of **per-* ("forward, through") (https://en.wiktionary.org/wiki/experiment#Etymology). *Ex* and *perior* can be interpreted as an explicit reference to the external world, beyond the mind. This combines notions of empiricism in contrast to pure reason, what Kant would contrast as *a posteriori* and *a priori* knowledge. This philosophical dichotomy does not quite match practical reality— our experiences are often some blend of our senses and mental abstraction, and experience does not always serve for the production of knowledge. This quick diversion is useful in pointing out the vast open-endedness of the concept of "going through in the external world". Of course, a purely etymological approach to language neglects constantly evolving socially constructed meanings, which are a better indicator for the present consensus and usage of the concept.

4.1 Existing Theories of Urban Experimentation

With this definition of urban experimentation, academics have all outlined approaches that I would argue are "feeling different parts of the elephant", each with their own bits of truth but then with unnecessary theoretical commitments that misrepresent the possibilities of urban change.

Most academics and members of the public associate experimentation with an innocent pursuit of knowledge under uncertainty—finding technical solutions to urban problems that may be material or regulatory. These approaches tend to disregard values-based conflicts or neglect institutional contexts and power relations, but are a useful reminder of a systematic process of exercising limited agency.

Critics of experimentation often argue that it is purely performance and coopted by powerful government or corporate actors. These approaches tend to assume that experiments make no material impacts, and thus disregard the potential for "coopted" experiments to also serve community need. The notion of experiments themselves as acts within the contexts they intervene in is an insight from this literature that is the backbone of the case study methodology and final conclusions.

Lastly, other critics position urban experimentation within broader trends of neoliberalization in the global political economy. These approaches take the "system" head on, but too quickly group urban experimentation with definitions of entrepreneurial competition amidst many examples of experimentation as cooperation. In doing so, they can veer into structuralist arguments that impractically disregard agency and the meaningful efforts by many urban experimenters to change the status quo. However, parts of these approaches are useful in studying urban experimentation, especially their explicit treatment of political economic institutions.

Chapter 5 takes the useful portions of each of these theories, in conjunction with findings from case studies, to create a new theory of urban experimentation as institutional change which acknowledges sites of agency under uncertainty, experimentation's role as an action itself, and political economic structure. The following subsections outline major concerns of each of these strands of literature in urban experimentation with more context to the above claims.

4.1.1 Experimentation as learning through science

The conventional vocabulary of urban experimentation— "samples", "replicating", "upscaling"— stems from a "science for policy" approach to urban issues (Hajer 2016, xix). These words generally derive from a positivist scientific empiricism in which we can isolate crucial variables, discover generalizable laws, and then apply gained knowledge to different contexts. The urban becomes a closed and controllable "system", in which all that is needed is the right combination of levers to be pulled by government to arrive at an optimal solution. Inherent in this approach is an emphasis on uncertainty and collective learning of the material, built environment.

In urban mobility, this "systems" perspective is dominant. For example, ridehailing and micromobility pilots are positioned as solving the "first-mile/last-mile problem", a concept from transportation network and operations research literature, reducing the need for costly dial-a-ride transit services and subsequent environmental emissions while meeting the same specified travel demands (e.g. Chandra and Quadrifoglio 2013). New mobility pilots are generally framed as discovering technical use cases and expanding mode choice to improve the workings of a techno-economic system (Urbanism Next Center 2020). At the most technical level, automated vehicle pilots such as those done by Waymo near Phoenix, AZ, are mostly executed to gather training data for algorithm improvement (Schwall et al. 2020).

As noted in Chapter 1 though, this conception of knowledge is just one of many, and its dominance is problematic. The increase in urban experimentation marks the reconfiguration of a past sense of techno-managerialism, associated with long range plans and sophisticated predictive models, with a techno-entrepreneurialism, invoking the city as a laboratory subject to the scientific method (analogous to Harvey 1989). Though this perspective has its merits as posing a formalized pursuit of alternatives to the status quo, an overreliance on this framing obscures important underlying institutional and political factors, and poses a limited range of solutions while neglecting other sites of agency.

An epistemic critique of the scientific view on urban experimentation can stem from John Dewey's critique of the "spectator theory of knowledge". In *The Quest for Certainty* (1929), Dewey confronts the long-standing epistemological obsession of privileging certainty and theory in a world where practical activity is inherently accompanied by uncertainty. In his view, any practical activity takes place in an individual situation within a unique context that is never exactly duplicable, a view in contrast to the experimental methods of natural science. Dewey recognizes the value of theory as helping us "make the wisest choice we can" (Dewey 1929, 6)— mitigating uncertainty, rather than striving for elimination in its entirety.

Many urban experimenters adopt the "scientific" mindset towards experimentation, striving for "best practice" technical solutions across urban situations that are complex, overdetermined, and institutionally diverse.[44] In order to rigorously test these solutions, experimenters carefully craft their experimental design and evaluation procedures, minimizing the weight of their "thumbs on the scale", in order to eschew criticism from the rest of the community of urban experimenters. Dewey's insights allow us to criticize this on two major fronts. First, rarely are urban experimenters free from their institutional contexts, and a large portion of their work is not in experimental design and data analysis, but rather in catering to powerful groups for funding, or overcoming difficulties of experiment implementation from antiquated procurement procedures to establishing trust with participants or publicizing the new experimental changes.[45] Secondly, rigorous evaluation procedures are often prohibitively expensive or subject to data sharing negotiations with private providers, and many practitioners actively put in efforts to ensure their experiments' success, indicating a position by implementers of urban experimentation as not solely a detached, scientific endeavor. In essence, though a prominent framing within the popular discourse, urban experimentation as a "science" misses much of how it actually gets done.

Even more insidiously, the "spectator theory of knowledge", along with claims of minimizing bias and being "value-neutral", obscures inevitable power relationships that urban experimentation creates. Generally, experiments "imply a power dynamic whereby certain (more powerful) groups are experimenting on other (less powerful) groups with the purpose of transforming or transitioning them" (Evans, Karvonen, and Raven 2016b, 4). The "value-neutral" narrative pushed by academics and practitioners feeds a powerful funding apparatus consisting of government, philanthropy, private

[44] Critical urban scholars have taken from Althusser (Desan and Steinmetz 2015) and other scholars' concept of overdetermination as useful in the urban context (Lefebvre 1970, 45). The complexity of the urban is a motivating factor for study and explicitly mentioned by Lefebvre: "Today, the urban phenomenon astonishes us by its scale; its complexity surpasses the tools of our understanding and the instruments of practical activity" (Callon 2007, 317)

[45] For one example, see Stacey Matlen, Hind Ourahou, and Mark de la Vergne. 2020. "Job Access + New Mobility White Paper." City of Detroit Office of Mobility Innovation Unpublished White Paper.

companies fueling the "knowledge economy" (May and Perry 2016). Often sidelined are community-oriented efforts of collaborative experimentation, which are unable to amass the same legitimacy from academia.

Lastly, the scientific view on urban experimentation underestimates sites of agency— relegating interventions to merely tinkering to find clean material solutions when experimenters are actively involved in creating and maintaining the "problems" that they seek to solve. Experimentation as a science underestimates how much the urban is subject to change, and thus glosses over key sites of agency (Dewey 1929, 16).

4.1.2 Experimentation as rationalizing policy

The scientific ethos has translated further into the fields of "policy science" and "policy analysis", dubbed the "rationality project" by Deborah Stone. In this, many academic fields of political science, public administration, law, and economics have had "a common mission of rescuing public policy from the irrationalities and indignities of politics" (Stone 1988, 9). A common framing in this debate is dividing beliefs into *facts* and *values*. Harold Lasswell, pioneer of the "policy sciences", compartmentalized these two arenas, in which *values* are incorporated into the choice and definition of problems, which are then sent into the scientific pipeline of *facts* and "problem-solving" by social scientists and policymakers (Turnbull 2008, 76; Lasswell 1951, 14). The separation between *facts* and *values* is the core assumption that many critics attack— "is it possible to fix social values, or do they change with the very process of inquiry regardless of the goals set?" (Turnbull 2008, 76). Most recently, the debate has shifted to recent calls for "evidence-based policy",[46] where rationalists and constructivists have long contested the role of knowledge in public policy (see Newman 2017).

In urban mobility experimentation, a large focus has been on regulation of and adaptation to new technologies.[47] For example, given the lack of federal automated vehicle (AV) regulations, states have produced a variety of regulations based off of model policies, which for onlookers looks like a regulatory experimentation out of necessity (Schuelke-Leech, Jordan, and Barry 2019). At the local level, Freemark et al. (2019) found that cities have generally not "prepared" for AV's, though they can collectively maximize policy "advancement" by working across cities to develop "best practices". Another example of regulatory "experimentation" is the politics of Uber in the United States, which can be described as an experimental race between Uber and city regulators across different cities. Generally, this experimentation has been more fruitful for Uber by learning to capture and avoid regulations (Armstrong 2020; Collier, Dubal, and Carter 2018), though cities have also been learning from TNC operations and are experimenting more with integrated public models (e.g. Via pilots).

The search for the "best practice" model of policy or regulation is subject to similar critiques as in the previous subsection, with the main actors being policymakers rather than purely engineers or scientists. First, the question of "what counts as evidence" is never an uncontested, objective fact. For example, "evidence-based policy" usually favors quantitative methods over qualitative methods of gathering

[46] A common response to Trump's attack on "fake news" and reminders that "what you're seeing and what you're reading is not what's happening" is a return to this "evidence-based policy". I would argue that this endeavor is riddled with exclusionary and undemocratic perils.

[47] During the pandemic, many cities have experimented with reallocating street space to account for the decrease in travel, from creating community spaces to outdoor dining. This can also be seen as experimentation around previous regulations that established the use of space.

evidence. This reliance reinforces the exclusion of experience and lay knowledge that cannot be easily quantified, and thus downplays the experiences of those most marginalized (Newman 2017, 8). Even further, the requirements for quantification already impose a biased filter on the hypotheses that can be asked within an experiment. Further, according to one critic of evidence-based policy, "What really happens in the public sector is that we adopt, or at least conform to, the ontologies of the day and the views of knowledge embedded within them even when they do not reflect reality" (Adams 2004, 33)— a reminder that public sector actors are also subject to change with the hegemony of the times.

Further, urban experimentation is deeply intertwined with the "knowledge economy", and the rationality project has created a new professionalized troop of consultants to carry out outsourced government policy work. This has taken place alongside the rise of the "new public management", a public sector reform movement focused on efficiency, effectiveness, and value for money, much like lean production systems (Linovski 2019). One problem is that such efforts hollow out governmental capacity while promoting a seemingly apolitical reform (following sections; Brenner and Theodore 2002; Linovski 2019). While coopting the "value neutral" façade, these consultants and technocrats wind up cementing their own definitions of good and bad, right and wrong, ultimately maintaining a particular top-down power structure (Newman 2017, citing Foucault).

Lastly, a major critique of the "policy sciences" is that it often has little impact on the policymaking process, the reason being that politics is an unavoidable part of the process. Generally, when policy analysts are told to evaluate a policy, they are only told vaguely what values or value-derived goals to evaluate (Rein and White 1977, 270). Therefore, often these values are left up to the analyst, handing the political process over to the scientific community acting beyond their professional competence. To the extent that policy analysis does get "used", it is less so *instrumental,* as in directly leading to policy solutions, but rather more *conceptual*, affecting policy slowly and indirectly through the discourse, or *political*, as rationalizations of predetermined policy choices or tactical gestures (Newman 2017, 3).

This is not to say that "science" and an emphasis on objectivity is not useful at all. Appeals to commonly accepted evidence can be effective in creating consensus. Pielke (2004) offers a simplified version of this in his thought experiment with "tornado politics", policy contexts where information matters and there are common goals, and "abortion politics", where information does not matter as much as different values and the negotiation between them. He argues that science is indeed useful in contexts where values are largely shared (e.g. self-preservation when a tornado is coming), though would be foolish to bring up as support of primarily values-based arguments (e.g. for or against abortion). In the case of transportation, the long-held assumptions of shared value-derived goals (e.g. level of service, vehicle miles traveled, more highway lanes) are being increasingly contested, pointing to a greater need for a focus on mobility *politics* rather than mobility *science*. Ongoing urban mobility experimentation can be seen as one component of the rationalization of policies which de-politicize inherently political processes (May and Perry 2016). With ever more attention on accessibility and the effects of mobility injustices, efforts at finding "best practice" regulations for technologies or novel models of service delivery through experimentation largely miss the crux of transportation's political and values-driven issues.

4.1.3 Experimentation as performative

In critiquing the detached "scientific" epistemologies surrounding experimentation, a rich line of inquiry has emerged through the concept of *performativity*, which bridges the classic dipoles of facts and

values.[48] From the field of linguistic philosophy, J. L. Austin introduced the concept in a series of lectures at Harvard in 1955, distinguishing between a representational view of language (e.g. "the cat is on the mat") and "performative utterances" (e.g. "I do" when getting married, "wingardium leviosa"). Eventually, he outlines how all utterances contain some amount of use beyond their meanings; that all utterances are "speech acts" (Callon 2007; Austin 1962).

Austin's performativity has been widely adopted in the humanities, though is left open-ended— in what ways do utterances "act" in different social contexts? A prominent investigation of performativity questions the role of financial academics and models in the construction of markets. Scholars have shown that financial models such as the Black-Scholes-Merton model of option pricing, once thought to be a "camera" analyzing markets as an external thing are better thought of as "engines" that shape markets, often akin to a "self-fulfilling prophecy". MacKenzie (2006) offers a stronger definition of performativity for economic models in their ability to make economic processes conform to their depictions ("Barnesian" performativity) or in their ability to do the exact opposite (counterperformativity) (see also Bamford and Mackenzie 2018; Callon 2007). This line of inquiry highlights different ways that knowledge production is performative, acting within the processes in question rather than just commentating externally.

The concept of performativity has also aided feminist and queer theory in conceptualizing the social construction of gender. In a rather outdated text, Erving Goffman (1956) employs the metaphor of the theater when describing everyday interpersonal interactions: "When people present themselves to each other… they present not so much *themselves* but a *self,* a persona, a mask. They act as if they were on stage. They *perform*" (described by Mol 2003, 34). Judith Butler (1990) went even further to say that a concept of a backstage, true identity does not exist, and that gender is constituted by pervasive and mundane acts of performance. In this, parody (e.g. drag) is a kind of destabilizing act which showcases often-invisible assumptions (e.g. of an "original" gender) and the contingency of gender as performance (1990, 175). In response to this untethered constructivism, Callon (2007) and Mol (2003) draw attention to the neglected materiality (e.g. sexual organs) that does not fully determine, but certainly contributes to the construction of gender in many contexts. Performance thus acts within textual and material contexts which comprise a sociotechnical *assemblage*, a mishmash of different elements that have been carefully adjusted to one another and dictate the capability to act in different ways (Callon 2007, 320).

The theatrical metaphor of performance has also been used in the conception of *sociotechnical imaginaries* as "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff and Kim 2015, 4). These imaginaries are often shared visions of progress and modernity, are fueled by experiment and demonstration, and are framed as creating legitimacy, especially for the democratic state. Like Callon's sociotechnical *assemblage*, the sociotechnical *imaginary* draws the bridge between the long separated "social" and "material" to illustrate how technological systems and their performances are embedded into "masonry of political world-making" (Ezrahi, quoted in Jasanoff and Kim 2015, 12).

[48] For the Ancient Greeks, this was regarded as a separation between logic and rhetoric, a separation which has dominated mainstream thinking until J. L. Austin's contributions (quoted in Townsend 2013, 18).

Utopian visions of progress and modernity have long influenced the development of the built environment. In the context of urban mobility, the car was deemed meaningful and useful under a myriad of social roles, highways and traffic infrastructures, legal institutions, supply chains, and cultural touchpoints (Jasanoff and Kim 2015, 2).[49] The sociotechnical imaginary is explicitly enacted in the present, as scholars critique the latest efforts at "smart cities" and technological salvation by corporate and municipal discourses (see Goh 2015; Townsend 2013; Sadowski and Bendor 2019). These efforts are seen as crowding out alternative visions of smart urbanism in favor of the ideals of tech giants such as IBM, Cisco, Siemens. Underlying these critiques is an idea that many urban experiments oversell and socially construct their "usefulness" without living up to their promises and creating unintended consequences.

Claudel (2020) similarly incorporates the concept of performativity into theories of value (1969, chap. 3) to pose a case of "*ex ante* value setting" by urban experimenters, as opposed to the "stochastic" case, where experiments are done without any given direction[50] and only evaluated *ex post*. In the performative case, the experiment is purely an act of demonstration in pursuit of objectives, acting to bring civic value within a relatively certain urban arena.[51] Here the concept of civic value is similar to Jasanoff and Kim's sociotechnical imaginary— largely reflecting the ideals of progress and modernity. *Ex ante* value setting also aptly describes the hype and headlines surrounding many urban experiments' launch, with much less attention towards their follow through, successful or not.

A theory of performativity within experimentation has been useful to destabilize the rationalist ideal, but also suffers from theoretical weaknesses (Claudel 2020). First, many fatalistically look at experiments as merely expressing existing power relations, always captured by corporate and governmental elites, and in doing so overlook experiments as a site of agency for shifting power relations themselves. One source of this fatalism is an underappreciation of uncertainty and contingency within the process of urban change, a challenge that the scientific and rational policy approaches try to tackle. Many interpret the existence of power relations as a call to take the power out and create a more "innocent" and systematic experimentation process, though there are alternatives to ping ponging between two poles of an ancient debate between science and politics.

As outlined by Foucault in Chapter 1, power is both coercive and *productive*; it is an inevitable part of doing anything in the world. Though urban experimentation can be used to push forward corporate dreams of automated automobiles and seamless ride hailing (e.g. Mobility as a Service), it also can serve as the site of boosting the perception and use of stigmatized transit and highlighting and addressing existing mobility injustices. It can act to advance messy, decentralized, and democratic alternatives by residents, activists, and entrepreneurs that have long been crowded out by top-down visions (Townsend

[49] Writing on the 1939 World's Fair, Walter Lippman wrote "General Motors has spent a small fortune to convince the American public that if it wishes to enjoy the full benefit of private enterprise in motor manufacturing, it will have to rebuild its cities and its highways by public enterprise"(quoted in Townsend 2013, 18)

[50] Much like the process of "creative destruction" outlined in Schumpeter (1943).

[51] In one circular logic, Brad Stone has coined the term "Travis's Law" after former Uber CEO Travis Kalanick, in which firms advocate to regulators that "Our product is so superior to the status quo that if we give people the opportunity to try it, they will defend it and demand its right to exist". Firms advocate to users that because they are users, they should pressure lawmakers to let it exist (Claudel 2020). These tactics are heavily used to create *performative legitimacy* for many urban platform economy firms, and in doing so create and construct the sense of value that they claim to be neutrally demonstrating.

2013; Sadowski and Bendor 2019). Urban experimentation is an "utterance" that acts within the context it intervenes in, and is far from insulated in its own laboratory.

4.1.4 Experimentation as a neoliberal project

A cadre of critical geographers and political economists situate urban experimentation within a broader surge in neoliberalism in recent decades. David Harvey offers a clear definition in *A Brief History of Neoliberalism*:

> *"Neoliberalism is… a theory of political economic practices that proposes that human well-being can best be advanced [progress] by liberating individual entrepreneurial freedoms and skills within an institutional framework characterized by strong private property rights, free markets, and free trade"* (Harvey 2005, 2).

Urban experimentation fits as the competitive process within free markets in which different experimenters compete for the best result. A market can be defined as "a meeting place for the purpose of barter or buying and selling" (Polanyi 1944, 59), which usually is characterized by commodification and standardization, the use of money and setting of prices, and most importantly centralized *competition*. Polanyi (1944) empirically shows how markets have long been a part of society, dating back long before the Industrial Revolution. Liberalism, however, brought along an ideal of the *free* market with an evangelizing mandate— if markets in a context do not yet exist, they must be created by a limited state.

The free market in neoliberalism is a central institution for progress and morality. To liberal economists, the major mechanism for this technical progress (i.e. growth) is a division of labor in which actors can focus and specialize in what they do best (Hirschman 1982). Others emphasize the competitive nature of free markets (and capitalism), which encourages *innovation*, or "the setting up of a new production function" (Schumpeter 1939, 84). Competitive and free markets incentivize self-interested entrepreneurs to innovate with the allure of profit through a temporary monopoly.[52] The market decides which innovations are "good" ideas, by allocating profits to the "good" and allocating losses to the "bad", which eventually die out through the process of "creative destruction" (Schumpeter 1943). Urban experimentation here fits as a part of capitalism's social progress—the fits-and-starts of innovation leading to progressively better ideas of how to organize resources within the urban environment.

Committed liberals take this argument to its extreme: if the market is the most efficient judge of ideas, the market for urban experimentation must be as "free" from state intervention as possible to maximize growth. Libertarian thinkers like Thierer (2014) hold an aversion to technology policy based on the "precautionary principle", which generally advocates for caution under uncertainty. Instead, Thierer argues for a wholehearted embrace of "permissionless innovation", in which experiments are conducted by the private sector while unabated and undirected by the Leviathan-like state.[53] In essence, this is captured by "move fast and break things" as not just an approach for a single firm, but for all of society.

[52] Patents are an example of this arrangement formalized, but this also happens informally through differentiation.
[53] The connection between "permissionless innovation" and economic growth has created the field of evolutionary economics, in which economics is understood via evolutionary science rather than rational choice. This was seen as a major advance in accounting for change by deemphasizing stable market equilibria, but also suffers from its own naturalism and singular adherence to markets.

Polanyi (1944) offers an incisive critique to this "permissionless innovation" version of urban experimentation:

> *"Fired by an emotional faith in spontaneity, the common-sense attitude toward change was discarded in favor of a mystical readiness to accept the social consequences of economic improvement, whatever they might be… A belief in spontaneous progress must make us blind to the role of government in economic life"* (35-39).

In this, Polanyi draws attention to the social (state-sponsored) construction of supposedly "free" markets to counteract the naturalism that romanticizes spontaneity. The idea of a socially constructed and *changeable* social order of society is a modern idea rooted in the Enlightenment era, and the mechanism by which society (including markets) is constructed is generally "undertheorized", reductively explaining human agency by position within social structure or natural, rational self-interest (Fligstein 2001, 30). *Institutions*, the rules, sets of practices, and norms that shape social, economic, and political relationships among organization, have become a useful unit of analysis to understand societal building, stabilization (North 1990; Scott 2014). Economic sociologists have outlined four sets of institutions that produce social structures relevant to markets: property rights, governance structures, rules of exchange, and conceptions of control (Fligstein 2001, 32). These are purposefully open-ended and abstract concepts, and the variation in their definition leads to drastically different outcomes and cement particular power relations (akin to Hall and Soskice 2001).[54] What these approaches make clear is that notions of neutral and natural experimentation often mask underlying power relations, which in the US context favor those with capital.[55]

Critical geographers connect neoliberalization in the US political economy to its implications on spatial dynamics at different scales (e.g. Brenner 2019; Peck and Tickell 2002). Following the capital accumulation crisis of Great Depression, a wave of federal urban policy (i.e. expenditures and programs affecting social development within cities) encompassed both the New Deal and Great Society (Florida and Jonas 1991). Neoliberalism arose through the crises of U.S. Fordism through the 1960's and 1970's, best known for stagflation, oil shocks, and the collapse of the Bretton Woods gold standard (Harvey 2005). During the Reagan counterrevolution in the 1980's, the "destructuring" process of federal institutions transferred administrative responsibility to states and localities, and dismantled many of the income maintenance and social programs of the Great Society. A "new localism" (devolution) emerged in which states and municipalities "adopt entrepreneurial strategies in order to attract external capital investment to their territorial jurisdictions" (Brenner 2002, 8; Harvey 1989). Calls for a "new regionalism" seek to band together interconnected economies as competitive units to mitigate the consequences of hyper-competition, but is far from a comprehensive solution. The "survival of the

[54] For example, for property rights, defined as who has the rights to claim surplus, rules may be set up to favor capitalists and the most privileged (e.g. the US), but also can be set up in cooperative models with equal distribution for profits, or worker-centered models with profit-sharing.

[55] For example, an elite club of venture capitalists are the faces behind "the market" in many startup fields, who many times make investments in "innovations" that wind up falling flat while crowding out potentially profitable ventures. Through this they face many similar criticisms to when the government directly invests in innovation itself. See Eric Levitz. 2015, February 10). America Has Central Planners. We Just Call Them 'Venture Capitalists'. *New York Magazine.* https://nymag.com/intelligencer/2020/12/wework-venture-capital-central-planning.html.

fittest" mentality[56] has largely manifested in increased poverty, homelessness, and other quality of life outcomes and crises of fiscal austerity (Peck 2012; Phinney 2018; Brenner 2002).

Hence, with devolution came the rescaling towards the "urban" and a competitive drive for increased "experimentation". Municipalities and regions position themselves as competitive often through performative measures: "Looking smart, perhaps even more than actually being smart, is crucial to competing in today's global economy" (Townsend 2013, 10). Specifically, competing in the global economy points to the increasing need to compete to attract the "creative class" via talent, tolerance, and technology (Florida 2012). Urban governance increasingly focuses on the management of territory as a collection of real estate markets for development, and the negotiation of control with philanthropies and investors (Akers 2015) using experimentation as a key tool. A system of credit markets and rating agencies whets an appetite for "fast policy" for cities to gain competitive edge, swapping more deliberative, developmental approaches for accelerated cookie-cutter policy designs and urban experiments that favor technocratic and well-resourced multilateral agencies (Peck and Theodore 2016). Increased urban experimentation here is seen as an inevitable product of structural political economic processes.

It is enlightening to situate urban experimentation within these approaches in economic sociology, political economy, and critical geography. However, oftentimes these approaches are quite abstract, vague, and hidden within inaccessible language. They can offer excessively grandiose suggestions for practical action or require much theoretical stretch work to ground them into practical study.[57] They also heavily emphasize building up existing theories of the market and the state, which already struggle to grasp changes in sociotechnical systems such as the rise of platform firms (Claudel 2020, chap. 2). The state has started to resemble the market (i.e. cutthroat localism) while the market has started to resemble the state (i.e. venture capitalists), making the distinction increasingly blurry. This thesis follows Claudel in opening up the space for an alternate, more grounded, and interpretable conception of urban experimentation as *emergent*, characterized by embracing uncertainty, learning by doing, and being focused on incremental but meaningful sites of agency.

4.2 Methodology

> *"Follow your nose wherever it leads you"* (Max Gluckman, quoted in Handelman 2005)

This part of the thesis embraces an exploratory methodology fitting the spirit of the topic. The case studies are based on three semi-structured interviews with urban experimenters in SE Michigan's mobility scene, as well as extensive documentary analysis and background from a broader research project. The three case studies were chosen with certain commonalities—the geographic region, their

[56] This has been promulgated by influential urban economists such as Ed Glaeser, who advocates for a Darwin-esque economism that neglects variegated geography and social attachments to place: "Places decline and places grow. We shouldn't stand in the way of that". Quoted in Jon Gertner. "Home Economics". *New York Times.* Mar. 5, 2006. https://www.nytimes.com/2006/03/05/magazine/home-economics.html.

[57] As one professor opined on insights from critical geography: "The world was being re-described (sometimes endlessly) but many of the terms of those descriptions were vague and I was not sure what to do with them in empirical work".

position as underrecognized stories, and their efforts to improve accessibility. They were also chosen to encompass an array of situations with a variety of actors, scales, technologies/modes, approaches, intentions, and outcomes. In the first case, *EZ Ride* was a small-scale experiment in the 2000's with an earnest but unsuccessful effort by community-based organizations at innovating in community-based transportation. *refleX* was a multi-million dollar bus rapid transit pilot following Detroit's recession recovery, which was spearheaded by a motivated A-team of transit planners and bridged the longstanding city-suburb divide. Lastly, *Night Shift* was a small mobility-on-demand pilot in partnership with Lyft, using a human-centered design approach to solve a specific problem of night-time access.

The methodology is largely rooted in the *extended case study*, which emphasizes "dwelling in place" alongside those you make "other" with aims for a reflexive science. It involves the reconstruction of existing theories of urban experimentation by stress-testing them against a few underrecognized case studies. It also takes advantage of my position as a Master's student—in a methodological learning process and balancing academia and practice—to question liberally, gather accessible contacts, and explore. Given the COVID-19 pandemic, physical immersion in SE Michigan was replaced by phone calls and a close virtual following.

Major limitations of extended case methodologies to remember are "power effects" including: 1) domination or being dominated when inserting one's self into a hierarchy; 2) silencing of repressed voices; 3) objectivizing social forces; and 4) normalization of problematics (Burawoy 1998). Further, qualitative interviews are always subject to agent inflation, where actors exaggerate their foresight, rationality, or creative entrepreneurism when recounting events (Peck and Theodore 2012). Most dangerous though is finding *embedded objectivity* without the conventional but limiting processes of *procedural objectivity*. Instead of trying to establish a definitive "truth", this thesis seeks to outline the realities of perspectives of urban experimenters as deeply as possible.

Each case study will begin with a narrative surrounding the case in question, creating a history of urban experimentation processes that are usually not well documented. Key ideas from the case will follow, stress testing interpretations from the theories above. Lastly, a comparative analysis across multiple dimensions will end on a synthesis of the reconstructed theory of urban experimentation as open-ended institutional change.

Chapter 5: Case Studies in Urban Experimentation in SE Michigan

For a place that brands itself through some form of "Detroit hustles harder" since the early 1900's (Desan and Steinmetz 2015; Neill 1995), urban experimentation should surely by on the radar. This chapter does three deep dives into case studies of urban experimentation, applying the theoretical setup in the previous chapter. Each case study begins with a historical context, followed by a narrative of the actual experiment, and ending with a synthesis of key ideas and lessons learned for the future. The final section is a comparison across cases to understand better the possibilities of understanding urban experimentation as open-ended institutional shifts.

5.1 *EZ Ride*: Technologically enabled coordinated community-based transportation services

For those who cannot drive a car or take a bus for whatever reason, getting around to live life within society can be extremely difficult. This situation happens quite often: seniors may not have the physical ability to continue driving[58], low-income individuals may not be able to afford a car and may not live near a bus stop, or some may require door-to-door assistance due to physical and mental disabilities. In these cases many individuals reduce their travel, rely on friends and family to get a ride, make use of paratransit run by transit agencies, or rely on community-based services by religious and nonprofit organizations. This case study is about efforts by a nonprofit on Detroit's Eastside from 1998 to 2008 to improve upon community-based transportation services. This initiative, called *EZ Ride*, was initially funded as a pilot program to coordinate the many community-based services in the region. It was positioned as both making transportation more technically efficient and also helping strengthen the network of community-based organizations (CBO's) in the region.

5.1.1 Detroit's Empowerment Zone

EZ Ride rode a wave of planning fervor surrounding the Clinton administration's announcement of the Empowerment Zones program in 1993, itself steeped in a long and contentious history of government-sponsored redevelopment programs. From the 1930's through the 1970's, cities across the US implemented public housing, urban renewal, and Model Cities programs which made indelible marks on the city (Thomas 2015). By the time Mayor Coleman Young took office as the first Black mayor of Detroit in January 1974, economic disinvestment, severe population loss, and racial spatial segregation was rampant.[59] In January 1975, the federal government consolidated many of its special grant programs through the Community Development Block Grant (CDBG) program (Thomas 1992). Through this transition, CDBG programs sought to minimize federal prescription for local spending, but in doing so vastly expanded the number of communities eligible for funding, oftentimes spreading the already

[58] AAA1-B in SE Michigan handles this situation delicately, with Mobility Options Counseling for individuals concerned about older adults (https://aaa1b.org/services-and-seniors/transportation/). Oftentimes though, aging drivers will only stop driving after an accident or near accident. Given that drivers aged 65 and over have the highest crash rates of any age group, and are more likely to kill or injure themselves in a crash, a wiser tactic is self-regulation before anything bad happens, which requires other means of getting around (Rudman et al. 2006).

[59] See many accounts of Detroit's history for this important clarification— Detroit's struggles are not so much the fault of one Black mayor but rather the accumulation of larger political economic shifts and a long history of organized and racialized deprivation of the city. Urban renewal and the decimation of Black Bottom/Paradise Valley is an oft cited example. Classics include Sugrue's *Origins of the Urban Crisis* (1996), Thomas' *Redevelopment and Race* (1992), and Farley et al.'s *Detroit Divided* (2000). Hackworth's *Manufactured Decline* (2019) is a recent addition.

shrinking “peanut butter” away from Detroit to less distressed cities or suburban communities (Briggs 2014; Thomas 2015).

The City of Detroit used these funds in three major ways from 1975-1994. First, they completed and expanded on urban renewal projects in a continuance of the city’s overall urban renewal agenda. Second, under pressure by community groups, the city council created the Neighborhood Opportunity Fund (NOF), which allocated funding to community-based organizations via applications. The NOF is interpreted as a “political porkbarrel” program to appease community groups, capped at 10% of the city’s CDBG allocation while also quieting many oppositional neighborhood organizations (Bachelor and Jones 1981; Bockmeyer 2000, 2428).[60] The lion’s share of CDBG funding was directed to large economic development projects centralized in the central business district (CBD), riverfront, and industrial areas. During the first phase of CDBG allocations from 1975-1982, 40% of geographically identifiable CDBG allocations ($62M) were made in the CBD or the riverfront (Darden et al. 1987, 194–96). Uncounted within this are usages of CDBG funds through Section 108, which allows cities to borrow against future CDBG allocations to help finance other projects, a practice which supported controversial investments in GM’s Detroit-Hamtramck Assembly Plant[61] and the Joe Louis Arena. Though city councilmembers were uneasy about such usages of CDBG funds, they ultimately justified them by the need to attract and retain business developers, and to attract other federal funds such as Urban Development Action Grants (UDAG).

Neighborhood organizations saw the Young administration’s “pragmatic accommodation for the private sector” (Neill 1995, 124) as a betrayal by the public sector and weakening the dreams of Black self-determination that Young represented. As a result of this sense of betrayal, community groups began to organize into a robust, mutually supporting network. As one CDC executive director explained, “Our expertise came from learning to out-fox Coleman after 20 years of tyranny” (quoted in Bockmeyer 2000, 2428). This community group capacity was a key factor in organizing around the Empowerment Zone.

The legislation authorizing Empowerment Zones (EZs) and Enterprise Communities (ECs) in August 1993 was a response to the need to “do something” following the Los Angeles riots in 1992. Through a competitive application, HUD would choose six urban EZs which would each receive $100M in federal social services funds over ten years, as well as other funds and incentives for EZ businesses to hire locally, in return for the city’s obligation to follow a well-charted ten-year plan for economic development, public safety, housing and community development, transportation, and many other areas (Thomas 2015). In a break from federal urban policy in the past, the EZ application criteria emphasized community-based partnerships as one of four basic principles. In efforts to equalize the application process, HUD hosted several regional conferences in February 1994 across the US to answer questions and clarify application requirements.

[60] $24M was allocated to the NOF from 1975-1982 of a total of $345M of CDBG allocations, a large portion of which went to “community development administration” (11%), “neighborhood strategy areas” (9%), and demolition (8%). 45% of CDBG allocations went to geographically identifiable areas counted above. Unfortunately, many cities’ CDBG performance reports are not specific enough to reveal spending patterns (Darden et al. 1987, 192)

[61] For GM’s plant in Poletown in 1980, the city “razed 16 churches, 2 schools and a hospital and displaced 3438 inhabitants” (Bockmeyer 2000, 2424), and further delivered only half of the promised 6000 jobs. To add fuel to the fire, the council dug into the NOF to pay legal debts incurred from the Poletown projects.

At the same time, Detroit was going through a major political turnover in 1993 as Mayor Young did not seek reelection. Under these circumstances, the newly elected Mayor Archer had to restructure the bureaucracy, recreate a regional political coalition, manage a deficit budget, all while the EZ application was a top priority. Whereas many cities started their EZ applications in late 1993, Detroit did not start their application process until February 1994, when a small citizen-based group selected the EZ, a process already filled with different interests trying to make sure their communities were included. An official EZ coordinating council, the governing body for the whole application process, was established in late March. The deadline for applications were due on June 30, 1994, and so the city had to move quickly to be able to get the application done on time.

Small flaws in the minutia of the EZ legislation created huge problems throughout the application process (Thomas 1995). Though federal officials attempted to be open and helpful about the criteria and processes, there turned out to be two contradictory sets of 24 criteria based on four basic principles, with no clear way of discerning which to prioritize. Another cause of unnecessary headache was HUD's encouragement of municipalities to coordinate their EZ applications with CDC applications for tax benefits, which had an earlier deadline of May 16. This further rushed the already compressed timeline for the EZ application, which contributed to significant anxiety, burnout, and dropping out of citizen volunteers working on the EZ application. In some respects, the messy EZ application process was a test to identify the fittest community-based coalitions among cities, in efforts to target those most likely to succeed.

Despite a less-than-perfect process, the EZ application process was full of economic hope and vision-making—"the magic took over" (Thomas 1995, 222). Mayor Dennis Archer seemed to have departed from Young's private sector emphasis by including CDC leaders on his mayoral campaign and positions in city hall, though he ultimately followed a similar redevelopment agenda through engaging Detroit's corporate leadership and celebrating the development of sports stadia and casinos (DiGaetano and Lawless 1999). On December 21, 1994, President Clinton announced the EZ designees with special attention to Detroit: "Just imagine: In Detroit, a city that was given up for dead 10 years ago, the private sector committed $2 billion to this endeavor".

Implementation of the EZ program again tested the distrust between the city and community groups, when many EZ contracts failed to be approved and implemented in 1996 (Bockmeyer 2000). Many of the well-connected CDC leaders, the strongest community voices in the EZ process, removed themselves from EZ governance to pursue other avenues, leaving community members that played more passive roles in EZ deliberations. Regardless, the Detroit EZ did indeed accomplish several things[62], from a number of retraining and education programs to creating a small neighborhood park (Thomas 2015). Academic evaluations of Detroit's EZ conclude that though some socioeconomic indicators improved via EZ investment (jobs, poverty, business investment), other indicators worsened (unemployment, housing investment) (Rich and Stoker 2010).

[62] Archived annual Detroit EZ reports from 1998-2005 detail most EZ initiatives, and can be found at https://web.archive.org/web/20060927131604/http://www5.hud.gov/urban/tour/showReport.asp?community=Detroit&state=mi&ID=26169800001

5.1.2 The Community-Based Mobility Strategy and EZ Ride[63]

As a part of Detroit's EZ plan, over 50 community-based organizations and transportation providers were brought together by the Metropolitan Affairs Coalition (MAC), a business lobbying coalition attached to SEMCOG, and DDOT to improve access to transportation in the EZ. This was called the Community-Based Mobility Strategy (CBMS) Task Force and was formed shortly after Detroit's EZ designation in 1995, with a primary goal of coordinating local transportation resources (Lyons and VanderWilden 2002). After "plenty of meeting" with a diverse group, the CBMS settled on an idea for *EZ Ride*, based on a centralized Automated Scheduling Dispatch System (ASDS) which would take in trip requests and output optimized and coordinated routes. This system was seen as a solution to problems for all actors. Providers (e.g. churches, community organizations) would be able to reduce deadheading, for example by being able to drop off customers to the airport for their jobs, and then return by picking up people with disabilities in western Wayne county for their day programs in the city, instead of returning empty. The closest and most logical provider would be called for each ride in an efficient manner, if they were willing to accept the fee. From the passenger's standpoint, transportation would be more accessible by providing a single number to call and reserve a ride, and breaking down each community organization's specific requirements for inclusion. The service would also fill gaps created through the schismatic opt-in/opt-out bus system and through the limited hours, eligibility, and service area of DDOT and SMART's federally required paratransit services. Upon reflection, executive director Calvin Jackson drew an interesting comparison: "I guess you might say it's like Uber today".

The CBMS task force identified the Detroit Assisted Transportation Coalition (DATC) as the lead agency, through its fiduciary agent and largest provider the Community Resource and Assistance Center (CRAC).[64] The DATC was a coalition of five community based organizations that provided transportation within the EZ, many which have since disappeared:

- CRAC
- Brightmoor Community Center
- Delray United Action Council
- Latino Family Services
- Council of Actions United for Service Efforts (CAUSE)

Collectively, the DATC provided around 80,000 trips a year, around half of which were provided by CRAC. This amount is not insignificant[65], and filled the gaps for the most marginalized populations furthest from transit service. This was done with 14 vehicles, eight of which belonged to CRAC. With *EZ Ride*, this ridership was projected to increase by 50-70% (120,000-136,000 trips per year). Ford Motor Company soon donated additional compressed natural gas vehicles for DATC to use, bringing the total number of available vehicles to 43 and greatly expanding capacity.

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[63] This section draws heavily from interview with Calvin Jackson, Executive Director of CRAC on the Eastside.
[64] CRAC went by many different names, including the Eastside Community Resource and Nonprofit Housing Corp and Special Citizen Area Transit (SCAT). The nonprofit officially dissolved in October of 2010.
[65] For perspective, DDOT's MetroLift and JARC programs had an annual ridership of around 443,000 trips in 2015, with paratransit ridership has steadily increasing in recent decades. See http://www.rtamichigan.org/wp-content/uploads/BEST-RMTP_StateoftheSystem_2015-09.pdf. The DATC also served harder to serve populations, as ADA only requires paratransit services within certain distances of existing bus routes, and their high expenses disincentivize transit agencies to serve these populations.

The service used a total of $30,000 from Detroit's EZ allocation, and an additional $225,000 was contributed by the Detroit Area Agency on Aging and various foundations.[66] This money was directed towards the purchase and implementation of the ASDS, which totaled from $230,000 to $330,000. The budget for personnel, operating expenses, and vehicle maintenance was around $4M for the two-year pilot, which MAC and DDOT helped raise from nonprofits, philanthropies, Welfare-to-Work grants, the Michigan DOT, and the Jobs Access and Reverse Commute FTA grants. As more sponsors committed funding towards *EZ Ride*, it became much easier for others to follow suit— a testament to the snowball effects of nonprofit fundraising.

When the CBMS decided on the idea for *EZ Ride* and secured two years of funding for it, they left the DATC to figure out how to implement and run the program. Given the centrality and coordinating role of CRAC, the rest of the case study centers their efforts.

CRAC was a small nonprofit providing demand response transportation services since 1979. It was situated in a small, split 1000 square foot office on the Eastside, and at one point had 47 employees, mainly including drivers and "jumpers" who would support deliveries and customer interaction. CRAC's annual budget, including all of its contracts, was around $3M, with around $1.2M from the state. CRAC was one of the largest nonprofit transportation services in Michigan, and took on multiple services in order to maintain the organization's financial stability, from Welfare-to-Work programs, to a Meals on Wheels contract to deliver hot meals to seniors, to private contracts with agencies for people with disabilities. This was unique, as most other comparable nonprofit services would not have the capital funding to provide services themselves (e.g. thus paying expensive cab companies) or would have to shut down due to inconsistent funding.

CRAC was also unique in being a community based organization that tried to serve all— many other community organizations had a particular sense of "their people", or did not have the capacity to do extra services (e.g. taking customers down stairs when no ramp was available). Amidst controversies in DDOT's behavior towards those in wheelchairs, CRAC's services addressed an unmet need. Though most customers were people who were low-income, senior, or disabled, CRAC also had contracts to provide transportation for large political events or well-connected suburbanites. Through this, CRAC drivers sometimes had to endure explicitly racist treatment and complaints.

Improper financial practices, beyond the on-off nature of grant funding cycles, made it especially hard for nonprofit transportation services to remain financially stable. For example, JARC grants were usually approved every October, and many grants were a 60-40 match of private dollars to public dollars. Money that flowed from the state would flow through the City of Detroit, but would often get held up within city bureaucracy for months—one time delayed by a whole year. On the ground, this would mean lost documents, excessive auditing processes, or in many cases, the city "paying somebody else out of your account".[67] During these tough times, CRAC would draw mostly on its private contracts to stay afloat.

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[66] Reported in the Detroit EZ's 2005 Performance Report https://web.archive.org/web/20060927132538/http://www5.hud.gov/urban/perms/printReport.asp?report=740.

[67] Though there were plenty of high points— good people working to transport and fill a community need, Calvin also remembers the low points… "walking around various city departments, hat in my hand, asking and begging for my money… and hoping that the check will cash once I deposit it."

The ASDS, though conceptualized sometime before 1998, was only finally purchased and installed in 2003. Vehicles were equipped to track location via GPS every time they were put in drive. Up until 2003, all of the trip coordination was done manually on handwritten route sheets, address lists, and name lists. Even after the software was in place, dispatchers often had to use their own judgement to make tweaks to the route (e.g. considering congestion trends, correcting software underestimates of bus capacity). Official tracking and reporting was done until 2005. With the automated system, expanded fleet, and injection of new funds, CRAC was able to drastically increase its ridership.

EZ Ride was meant to be a two-year pilot that, if successful, would expand beyond DATC to other nonprofits, hospitals, churches, and anybody else who used vans and buses.[68] Though many expressed verbal interest, this actual coordination never materialized. Eventually, grant funding from DDOT fizzled out as the city entered budgetary financial crisis in 2008. During the last two years of CRAC and *EZ Ride*'s existence, they were "running on a hope and a prayer", without the funds to tide over this dry spell of government money. Many of the vans and buses were sold to SMART or returned to the state of Michigan, while drivers dispersed, many leveraging their knowledge of the region by working for SMART. *EZ Ride* was indeed able to coordinate some transportation, with some informal coordination with friends from Washtenaw County. But in terms of the vision for deeper coordination—"that was just a dream".

5.1.3 Key ideas

EZ Ride was a unique case of community-based urban experimentation, in a practice where private companies and government usually dominate. It highlights several key ideas on urban experimentation:

Organizational capacity: Detroit's EZ application relied on a robust network of community organizations for its completion under a far-from-perfect process. Similarly, *EZ Ride* relied on CRAC's ability to persevere through unideal funding cycles and practices. Nonprofits on the margins are constantly fighting for their survival, and often are not able to build up capital assets or organizational capacity to run more efficiently, analogous to James Baldwin's quote, "it's expensive to be poor". Urban experimentation often assumes that the small scale is indicative of the large scale, and this case study questions that assumption.

Performativity: Money begets more money in the nonprofit world, and the MAC brought attention to *EZ Ride* in an arena that is usually on the margins, picking up leftover customers from other services. Under relatively low uncertainty, a modest technological fix was used to motivate coordination among different services and serve a more inclusive community, a much deeper institutional change. *EZ Ride* bolstered CRAC's legitimacy to create a seed of funding for expanding services, and was not very concerned with formal evaluation, relying on informal monitoring. This supports and flips the conventional narrative of urban experimentation as the flashy performance of private corporations or the state vying for legitimacy.

Institutional frictions: Poor budgetary practices and incautiously challenging EZ application processes magnified consequences in arenas where organizations were stretched thin. The EZ application's overambitious deadlines caused burnout and dropping out of motivated community members, the

[68] The vision almost grew with a contract with the Detroit Medical Center (DMC) to help transport EMS patients to the nearest hospital. This would integrate many of the DMC vehicles into the *EZ Ride* network. However, patients of one hospital getting care from another would cost "real dollars", and this ended the prospect of coordination.

lifeblood of the application's success. Unreliable grant funding is one reason why many community-based transportation services shut down.

5.1.4 Lessons for the future

1. It's not enough to just fund an experiment and "see what happens". A plan for "what happens next" and having all actors following through the whole experiment can create longer lasting impacts.
2. Consistency in grant funding can both increase organizational capacity of experimenters and prevent experimenters from leaving those who rely on experiments in a lurch.[69]
3. Urban experimentation directed by community voices can have very positive outcomes in better serving those with needs, but does not come easy. Community and organizational capacity are key for getting small scale initiatives off the ground.

5.2 *refleX*: City-suburb collaboration for a well-marketed limited-stop express bus service[70]

A phone call, an order of sweet potato fries, and a couple beers in late 2015 was the spark to a spirited initiative by transit planners to try something new. This was the start to *refleX*, a branded regional transit service offering high-speed limited stop routes connecting Detroit and the suburbs along the Woodward and Gratiot corridors. An express bus is not some new and fancy idea, but *refleX* did indeed plant seeds of change in the region—breaking down city-suburb barriers and injecting a determined optimism into a drab and isolated status quo. In that, *refleX* is an example of urban experimentation led by transit planners successfully pushing the region's institutional bounds beyond the technical, and towards a vision of a brighter future.

5.2.1 A tumultuous city-suburb transit history

refleX was a breakthrough for collaboration between SMART and DDOT amidst a contentious but overblown history. On notable time started in 1994, when newly elected Mayor Dennis Archer sought to fulfill the campaign promise of a DDOT and SMART merger.[71] This started as a pilot "route swap" in June 1994. Given duplicate bus operations along East Jefferson, Michigan, John R., and Fort Streets, SMART and DDOT would split the routes so that each was operated by only one agency. If successful, this would lead to a merging of maintenance facilities, and eventually all operations. Unfortunately, SMART had also accumulated a $7.7M deficit through its lack of a dedicated funding source. In 1995, SMART proposed its first property tax of 0.33 mils to suburban voters. Meanwhile, Mayor Archer was envisioning a 0.8 mil regional property tax for a merged service. Feeling betrayed by SMART's decision to fund its own suburban system, DDOT discontinued its cooperative service agreement, and both systems resumed duplicative service on all four routes. Both agencies pursued their own "anti-merger" ideas following the split, spending even more in duplicative services in each other's service areas in an

[69] OMI's Justin Snowden makes this clear: "We "pilot" new technologies, services in Black/Brown neighborhoods... the services vanish and residents who'd come to rely on the services are left in a lurch.... [Need] a "leave it better than you found it" approach to pilots." https://twitter.com/DetroitTransit/status/1318683648963608579. CRAC tried to provide services and manage its finances with this in mind.

[70] The following section is largely based on an interview with Neil Greenberg, former Director of Service Development and Scheduling at DDOT. Neil was extremely generous with his time and insights throughout this thesis and the broader research project.

[71] "D-DOT Suburban Bus Routes - 1994," Detroit Transit History, http://www.detroittransithistory.info/DDOT/DDOTsuburbanroutes-1994.html.

opportune era of robust transit funding. By the early 2000's though, in contrast to conventional wisdom, SMART and DDOT had found an equilibrium—effectively been operating peacefully in separate worlds, serving separate missions in significantly different geographic service areas.

The recession, bankruptcy, and emergency management brought devastating transit cuts to SMART and DDOT.[72] By 2016, DDOT's operations had finally stabilized with adding new routes, expanding schedules, hiring drivers, and engaging stakeholders in new ways.[73] SMART almost doubled its millage in 2014, solving capital and operating issues and opening up an opportunity for long-term planning beyond just "making do". The Regional Transit Authority (RTA) was formed in 2012 through state legislation as a coordinating body for the region's transit system.[74] Within this context, RTA acquired a $2M federal competitive CMAQ grant[75] for three years of "trial regional service", and conversations started in 2015 about its use for airport service or restoring cut SMART routes.

A return to old models did not satisfy some eager transit planners frustrated with the status quo. Further, the $6.5M/year to restore the previous SMART service into Detroit was beyond the scope of the given budget—attempts would be an inadequate recreation of something past.[76] Instead, transit planners from both SMART and DDOT came together to form "Team *refleX*" to challenge the preconceived notions of a very traditional transit planning practice, focusing on speed and simplicity rather than traditional ridership metrics.

5.2.2 refleX proposal and planning

In January 2016, spearheaded by DDOT's then Director of Service Development and Scheduling Neil Greenberg, this joint coalition revealed its proposal for *refleX* at a public meeting to the RTA board[77] with the following features:

- **Rapid and limited-stop service**. To do this, stops were spaced up to two miles apart. Travel time savings were around 10-15 percent of comparable routes, but perceived speed benefits of skipping what could be 100 local stops was huge. Long route lengths made them tests of truly regional service.
- **Interagency division of labor**. DDOT ran route 498 along Woodward Ave connecting the Somerset Collection mall in Troy to downtown Detroit. SMART ran route 598 along Gratiot Ave

[72] Associated Press. "SMART bus cuts start today". *MLive*. Dec. 12, 2011. https://www.mlive.com/news/detroit/2011/12/smart_bus_cuts_start_today.htm; and David Sands. "Detroit Bus Cuts Reveal Depths Of National Public Transit Crisis". *Huffington Post*. Jul. 16, 2012. https://www.huffpost.com/entry/detroit-bus-cuts-a-thousand-cuts_n_1647867.

[73] Mayor Duggan hired Dan Dirks in 2014 as DDOT's new director, taking over from MV Transportation, the private management company that operated DDOT from 2012. Dirks was a wise character with plenty of experience in the region that helped get DDOT back on its feet by 2016. See https://www.modeldmedia.com/features/ddot22514.aspx.

[74] The major feature of the RTA was the authority to propose property tax referendums ("millages") to fund regional service, though the RTA was also a conduit for federal funding in conjunction with SEMCOG.

[75] To be clear, CMAQ grants are particularly flexible. After tying the project to reduced carbon emissions, "Learning from Experiments: An Evaluation Plan for CMAQ Projects"

[76] See *refleX*'s January 2016 proposal: https://www.scribd.com/document/297147768/Reflex-transportation-proposal

[77] Motor City Freedom Riders. "Lack of Funding Will Limit Proposed Express Service". *Motor City Freedom Riders*. Feb. 4, 2016. https://motorcityfreedomriders.org/2016/02/04/without-more-funding-buses-for-new-ddot-smart-express-service-will-be-few-and-far-between/.

connecting Mount Clemens to downtown Detroit, with extra weekday service to Midtown and the North River Park and Ride. Given that fare integration was yet to come, passengers paid the fare of the agency operating the route (i.e. $1.50 for DDOT, $2.00 for SMART). *refleX* intentionally avoided framing itself as leading to any sort of "merger" to avoid unnecessarily evoking institutional baggage.

- **Simplicity and clear information**. Traditionally, riders in the region have to "inherit" their knowledge, needing a co-worker or family member to introduce somebody to the system. *refleX* aimed to keep thing simple with a handful of stops, with no complicated rules to boarding[78], and no deviations to random local stops at the whims of drivers.[79] The routes themselves mostly followed Woodward and Gratiot, avoiding confusing diversions, turnarounds, and backtracking. Signage, maps, schedule decals, and wayfinding materials followed an approachable and uniform aesthetic.
- **Product identity and branding.** *refleX*'s creators recognized that it would operate the best if marketed as new, shedding the decades of institutional baggage— and quite boring names of— the "Suburban Mobility Authority for Regional Transportation" and the "Detroit Department of Transportation". Hence its name is a snappy moniker inspired by the words *regional, flexible,* and *express*. In the grander scheme of transportation mode choice, transit branding and identity has been seen as a viable approach to overcoming the stigma of buses as dirtier, slower, and generally inferior to rail transit and automobiles. Transit professionals usually fail to capitalize on these opportunities given a focus on operations, engineering, and finance (Hess and Bitterman 2008). Good branding can be quite costly— just the vinyl wraps on the exterior of 10 *refleX* buses could cost up to $100,000/year— but was deemed worth the investment (Figure 5.1).

Figure 5.1 - Bus exteriors ordered from left to right: refleX (Regina Boone, Detroit Free Press), DDOT, and SMART (Matt Burb via CPTDB Wiki). refleX's aesthetic bump includes its vibrant color palette and clear service identifiers.

- **Proposed "top-ups" given further funding.** Given that the initial proposal was tied to a limited-term CMAQ grant, the possibilities for the idea quickly exceeded the allotted resources. Reflective of the team's attitude towards experimentation, their proposal included multiple "top-ups" beyond a baseline service, suggesting possibilities for higher frequency, route diversions, and new geographies (i.e. Midtown) should more funding arise.

[78] Prior to the 2011 cuts, traditional SMART routes required one end of your trip to be in the suburbs, though with plenty of exceptions. Functionally, this discouraged the long-spanning SMART routes from being slowed by local travel, which DDOT routes executed better. However, this added complication potentially created a perceived divide between SMART and DDOT riders.

[79] In contrast to the cases of past lackluster express bus efforts such as the Route 73 "Woodward Express".

Stakeholders at all scales were generally supportive of the proposal, barring concerns from the DDOT bus operator union and certain city council members that were quickly addressed. Top-level county executives and Mayor Duggan were generally absent from the conversations, given the small-scale nature of the project.[80] Eventually SMART and DDOT were given the greenlight, partnering with the RTA for funding strategy and support.

With the official stamp of approval, each of the three agencies appointed motivated and experienced staff members who were tasked with making commitments on behalf of their respective agencies. When complex issues arose, they would be tasked with finding the appropriate person for help. Starting in February 2016, the team set a standing meeting— first thing every Friday morning. Neil Greenberg recalls these meetings fondly:

> *"It is impossible to overstate how important this was. Meeting in the real world… it released us from the drab isolation of our offices. It forced us to mingle with the very people we were supposed to serve. It dusted the entire effort with an element of adventure and determination.*
>
> *Maybe it was the gently roasting coffee beans, maybe it was the lo-fi electronic hip-hop, maybe it was the inherent good vibes of Friday. In any case, I firmly believe our coffee shop "headquarters" put everyone in the ideal mindset for action."*[81]

The initial proposed service was estimated to cost $2.8M in annual operating costs, with dismal 75 minute headways, breaking a cardinal rule of transit: "*usable service – especially a new one – must operate every 60 minutes or better for a fair trial".*[82] Following the January 2016 public meeting, the RTA found funding from the state's Comprehensive Transportation Fund,[83] and local bus operating costs were shared as per arrangements made with the RTA in October 2015 (Table 5.1). The increase of annual operating funding to $5.6M allowed for a dramatic increase in headways to 45 minutes at peak hours and 60 minutes otherwise. Interestingly, this started to near the initial estimate to restore SMART's 2011 service cuts of $6.8M annual operating— though with a completely different energy that attracted the additional funding. Funding was loosely charted for a three-year pilot of the service, but *refleX* never made it to the end of its allotted implementation.

Though *refleX* was a "pilot", this designation did not change much about its implementation process from any other service change. At DDOT, *refleX* went through the full Title VI process, with public hearings and equity analyses. DDOT also learned from past community engagement open houses for new service changes, which were designed to be informal and interactive. Transit planners would come in with an idea that was 50% complete, and work with the community to take it to full development—a mix between top-down and bottom-up engagement. In this, advocates including Transportation Riders

[80] For reference, DDOT's 2016 operating budget was $119M, making this $2.5M/year time-limited initiative a drop in the bucket.
[81] Neil Greenberg, email to author, October 21, 2020.
[82] refleX proposal.
[83] The CTF is notoriously capped at 10% of the total revenues for the Michigan Transportation Fund, mainly from the gas tax. This cementing of the balance of a minimum of 90% automobile funding was enshrined in Public Act 51 in 1951.

United and Motor City Freedom Riders generally supported *refleX*, in that it was a much-needed service improvement and also demonstrated cooperation between SMART and DDOT.

Table 5.1 - refleX's First Year Proposed Budget[84]

Source	Capital	DDOT Operating	SMART Operating	Total Operating
Local Bus Operating (DDOT and SMART)		$500,000	$2,000,000	$2,500,000
Comprehensive Transportation Fund (MDOT)	$250,000	$371,750	$378,249	$1,000,000
CMAQ Airport Funding (MDOT and SEMCOG, facilitated by RTA)		$1,711,835	$260,165	$1,972,000
Estimated Farebox Revenue (20%)		$552,958	$552,958	$1,105,916
Total	$250,000	$2,764,793	$2,813,123	$5,577,916
Cumulative Surplus/Deficit		$371,750	$378,249	$750,000

5.2.3 refleX implementation and aftermath

Generally for grant funded service improvements, a tacit understanding should be made that the service will have to shut down at the end of the grant or new funding will have to be found. In general, this means patchworking funding sources for 10-year time horizons. *refleX* was a unique case of high uncertainty of how the service would turn out, and purposefully included no clear long-term plan. Instead, given the energetic A-team spearheading the effort, their positive attitude towards experimentation was brimming with agency. They were not so much concerned with an objective question of whether a step towards bus rapid transit would be useful. Rather, they adopted an attitude of "let's make this work", decentering the role of evaluation and data collection and centering on adaptability and entrepreneurial use of expertise and resources.

refleX was a positive and exciting moment for transit in the region, and accomplished some key results. After hitting the ground in September 2016, DDOT's Woodward *refleX* service eventually averaged 1,500 rides per weekday[85], though needing considerable ramp-up for publicizing the service and attracting riders.

This new coexistence of agencies proved fruitful. In 2017, the closure of Northland Mall lead to the redesign of a hub of twelve DDOT and SMART routes. Both agencies worked together to reroute, preserve connections, and disseminate information. Implementation here was smooth and well-received. In May 2019, the *DART* regional fare system replaced 50 different passes and cumbersome transfer costs with 8 simple regional passes— a major advance for customer experience and regional

[84] RTA Staff, Memo entitled "Reflex Update and Sub-Recipient Agreement Overview", August 18, 2016.
[85] As a rough perspective, 1,500 riders per weekday amounts to around 30 riders per trip and 30 riders per vehicle revenue hour, making it more competitive than many of DDOT's downtown and feeder routes. http://www.rtamichigan.org/wp-content/uploads/BEST-RMTP_StateOfTheSystem_2015-10-23.pdf

coordination. Though, advocates point out that this raised DDOT's base fare by $0.50 to $2.00, a significant increase without any accompanying discounts for low-income riders.[86]

In January 2018, SMART announced a slew of new service changes, including discontinuing their *refleX* route in favor of *FAST* (*Frequent, Affordable, Safe, Transit*). This was non-grant funded service—the model proved itself already— and ran service on Woodward, Gratiot, and Michigan Avenues, with prospects for a fourth corridor in the future. The service builds upon *refleX* with decreased headways on Woodward and Gratiot to 30 minutes, and sporting new dedicated bus shelters. Unfortunately, DDOT did not receive prior notice of these changes, and after four months of running alongside the *FAST* Woodward route, discontinued its service in April 2018. SMART's "go-it-alone" strategy for *FAST* was a break from the *refleX* arrangement, though it did scale up the service and freed DDOT buses for local service improvements.

5.2.4 Key ideas

Coalition building: Bridging decades long institutional divides can start with a single step. *refleX*'s small step led to unprecedented inter-agency collaboration in the following years.

"Let's make this work": As opposed to a "spectator" view of experimentation, the highly motivated and entrepreneurial team emphasized adaptability and was fully onboard to push their vision to fruition. While challenging the status quo, they kept many of the helpful institutionalized processes such as Title VI public engagement that ensure some accountability. No long-term plans were specified, but proposed "top-ups" helped attract more funding.

Top-down/bottom-up engagement: Though the pilot itself was mostly envisioned by eager transit planners, the model of hammering out "50% ideas" through public workshops did allow for bottom-up engagement.

Perception: *refleX* emphasized the customer experience, and emphasized simplicity, identity, and branding in an industry that usually ignores them. *refleX* also served as a demonstration for the possibilities of regional service in advance of regional transit ballot referenda.

5.2.5 Lessons for the future

1. Incremental efforts are a meaningful complement to "silver bullet" measures—mergers, regional ballot referenda, new technologies— that can distract from bread-and-butter investments. These incremental efforts are a key part of how "transportation offers a unique site of political possibility" by shifting coalitions and questioning the status quo (Glynn, Shen, and Goetz 2020).
2. *Who* does the experimenting matters. For *refleX*, picking the right team of motivated but grounded transit planners who were nimble and ready to adapt was crucial to success. Small practices like having weekly meetings in a coffeeshop "headquarters" fueled *refleX*'s energy.
3. Urban experimenters need to play the marketing game to get their experiments on the map, and to pass the first hurdle of adoption. "Glitziness" is not an automatic sign of cooptation by private interests.

[86] Larry D. Verse, Serena Cole, and Kim Smith. "Verse, Cole and Smith: Detroit bus service needs to hit minimum standards". *Crain's Detroit Business*. Sep. 22, 2019. https://www.crainsdetroit.com/crains-forum/verse-cole-and-smith-detroit-bus-service-needs-hit-minimum-standards.

5.3 *Night Shift*: Ride hailing subsidy pilot with reflexive feedback and iteration

As transportation network companies (TNC's) such as Uber and Lyft move past their infancy in the US, their relationship with governments have evolved beyond dropping in and "Ubering" different cities (Claudel 2020, 43; Stone 2017) to opening up new forms of public-private partnerships and regulatory capture. Government-sponsored grants and pilot programs often times support TNC's explicitly, allocating Uber or Lyft codes for social service programs. TNC's like Via explicitly brand themselves as companies that will cooperate with cities in implementing ride hailing technology to improve public transit. This case study of the City of Detroit's Office of Mobility Innovation's *Night Shift* pilot is an example of a recently created public sector team aiming to solve access problems systematically through a human-centered design process. In doing so they also push the evolution of new relationships between the government and TNC's.

5.3.1 The City of Detroit Office of Mobility Innovation[87]

When Mayor Mike Duggan was elected in 2014, the city was still under emergency management and was prioritizing short-term basic transportation service issues, essentially keeping the traffic signals on and getting buses out every day. By the time the US DOT announced the Smart Cities Challenge on December 7, 2015, the city was prepared for more long-term vision-making of its transportation system.

The Smart Cities Challenge was a federal attempt at stoking bottom-up innovation in transportation, much like the Empowerment Zone approach to broader redevelopment.[88] 78 mid-size cities submitted applications within the two-month turnaround (February 4, 2016 deadline), detailing holistic 30-page "vision narratives"[89] with potential programs and partnerships. Seven finalists were picked and given $100,000 grants to further develop application ideas and plans, and eventually on June 23, 2016, Columbus was chosen as the recipient of a $40M grant from US DOT and $10M from Paul G. Allen's Vulcan Inc. to supplement the $90M Columbus already secured from private companies. Detroit's application, entitled *From "Motor City" to "Mobility City"*, was egged on by big OEMs and suppliers and put together during off-hours by City of Detroit employees.[90] Given the accelerated time frame of the endeavor, community input was not much of a priority. Though Detroit did not make it through the first stage of the selection process, the conversations between Ford, GM, suppliers, the state, and the City of Detroit on the future of mobility stuck around.

Many cite the Smart Cities Challenge as creating the momentum for the latest wave of new mobility initiatives in the region. Detroit "lost out"[91] on $50M of federal funding, despite having the support of some of the most powerful auto industry actors. Many saw a lack of city leadership as the reason for not making the cut—the city focused too hard on basic services and bankruptcy, and was not present in many of the region's mobility conversations. In response, Mayor Duggan hired the city's first Chief Mobility Officer, Mark de la Vergne, in December 2016 to head the newly created Office of Mobility

[87] Based on an interview with Mark de la Vergne, Detroit's previous Chief Mobility Officer.
[88] The ethos of bottom-up innovation and cities as laboratories for smart cities was made clear by then Secretary of Transportation Anthony Foxx during the initial webcast: https://www.youtube.com/watch?v=hGKSOicdCdY.
[89] Taken from Notice of Funding Opportunity, https://web.archive.org/web/20171023152644/https://www.transportation.gov/smartcity/nofo
[90] See Detroit's Smart City Challenge submission at: https://www.transportation.gov/smartcity/visionstatements/Detroit-MI.
[91] Dustin Walsh. "City mobility stuck in neutral". *Crain's Detroit Business*. Oct. 23, 2016. https://www.crainsdetroit.com/article/20161023/NEWS/161029937/why-detroit-isnt-ready-to-be-mobility-city.

Innovation (OMI), one of the first of its kind in the country. Mark was trained as a systems engineer, and was working in transportation consulting before moving to Detroit.

The OMI's position within the Mayor's office gave it much more influence and audiences than if it had been in more traditional departments like Public Works or Transportation. The OMI was given little direction from Mayor Duggan, basically "think differently and get things done". Given that the OMI was a new model, it took a while to figure out its role before pilots and partnerships started to get off the ground. Eventually, the OMI identified its role as a facilitator by getting the most interested stakeholders in a room and creating partnerships. This is partly driven by the fact that Mark was given little operating budget, but enough for labor to hire a team of around six city staff and embedded consultants from WSP USA. Mark hired young, entrepreneurial, and consultant-type employees from the region to implement the office's pilots. Many of them are trained in human-centered design (HCD) thinking, which provides a heuristic framework for meeting needs through iteratively designed technical solutions and an emphasis on stakeholder feedback.

5.3.2 Night Shift[92]

One of the OMI's first pilots was *Night Shift*, a partnership that provided $7 ride hailing credits to supplement late night bus service. The process started 2017, when the OMI got funding from the New Economy Initiative (NEI), a coalition of Detroit-based philanthropies, with the help of the Detroit Economic Growth Corporation (DEGC) as a nonprofit fiduciary. With the Mayor's concerns about transportation barriers to job access and retention, ideation was done in a top-down approach building on the OMI's previous customer discovery work. The OMI proposed to start testing with a $7 credit for 2000 first-mile/last-mile rides for anyone using the most popular Route 53-Woodward bus (now Route 4) going to and from work between 12am and 5am, Monday to Friday. An RFP for such a ride hailing service was released in late 2017, and by February 2018 the contract with Lyft was finalized and signed. Through this process, Lyft negotiated a minimal data sharing agreement that later hindered evaluation efforts.

On May 8, 2018, "Woodward 2 Work" was launched, widely publicized through news stories, employers, and bus ads. Unfortunately, rarely anybody used the service. In September 2018, after 47 phone interviews with potential users, the OMI expanded the program to all of the recently redesigned ConnectTen 24-hour bus routes, and rebranded the service as *Night Shift* (Figure 5.2). After procuring more bus ads to advertise the program anew, there was a large increase in ridership, accompanied by mostly positive responses from 50 more phone interviews.

[92] The following sections draw largely from interviews with OMI Senior Mobility Strategist Stacey Matlen and Senior Transportation Planner at WSP Eric Hanss, as well as an unpublished whitepaper: Stacey Matlen, Hind Ourahou, and Mark de la Vergne. 2020. "Job Access + New Mobility White Paper." City of Detroit Office of Mobility Innovation Unpublished White Paper.

Figure 5.2 - Night Shift flyer (bottom) removed overcomplicated restrictions, added eye-catching design, and is much clearer compared to the Woodward 2 Work flyer (top);

In May 2019, in order to adhere to the FTA's taxicab exception[93], the OMI iterated again to add the taxi provider Detroit Cab, which gave customers a wider choice, allowed them to request wheelchair accessible vehicles, to request rides without a smartphone, and to pay for the remainder of their rides in cash. Given that this was the OMI's first pilot, technical issues arose. One example occurred upon increasing the number of ride providers, when some people with budget phone providers stopped receiving their Lyft codes. Fixing the problem rigorously would require $12K/year, far beyond the allocated budget. In the end, implementers made do without the robust fix, but with the consequences of less reliable evaluation data and higher turnover.

From July 2018 to July 2019, 272 riders took 1,695 of the 2,000 allotted trips using Lyft vouchers. In an evaluation done by University of Michigan Poverty Solutions using the limited data, they found that

[93] The FTA rule was that if there are two or more taxi providers for a program, there's no requirement to drug and alcohol test drivers. This is justified due to difficulties in testing with multiple companies, and is necessary given that Lyft does not mandatorily drug and alcohol test its drivers. See https://www.transit.dot.gov/regulations-and-guidance/shared-mobility-faqs-controlled-substance-and-alcohol-testing-requirements.

many people were indeed using the credit to cover short, quick trips. A few "mega-users" who used the service over 70 times raised some concerns of the long-term financial stability of the program's configuration. The lack of access to a smartphone or cellular data turned out to not be a major reason why people did not use the service, but credit/debit card difficulties were. Many used the service because it provided a safer and quicker alternative; one user cited "you literally saved my life countless times". Without more location-specific data beyond the census tract level though, any more details of how people were using the service were lost (e.g. were users actually going to bus stops?). Tracking phone numbers for phone interviews was one way to get feedback on their own without "without relying on benevolence from the private sector to share data".

5.3.3 Via Pilot during COVID-19

As the COVID-19 pandemic took hold in February 2020 with Detroit as one of its major early hotspots, the OMI switched gears for *Night Shift*, recognizing that the pilot's funding and contract was ending soon anyways. They pivoted the model to support essential workers commuting at night as a flexible emergency stopgap. Upon contemplating a second round for the pilot, the OMI sent out surveys to three of the biggest essential employers in the region—two big health systems and one grocery store—and found that many people were getting stranded without transportation, especially given transit service cuts.

To address this, they sent out an emergency RFP for a *Night Shift*-like service but with unlimited $2 rides at night, and five $2 rides per month during the day. This was run through the three essential employers, who played a key role in constantly reminding their employees of the service, as opposed to *Night Shift*'s one-time flyers. Via was chosen as the provider which, given their familiarity with public-private partnerships, smoothed the procurement process. Via's drivers are employees, and so legal liability and monitoring drivers were much less of an issue—an issue the OMI learned to avoid during *Night Shift*. Further, Via has a much more friendly data sharing policy that allows for granular and real time data through a secure server, and was much more cooperative in editing the in-app user experience to make the credit promo codes easier to handle.

On July 1, 2020, after a quick one to two-month RFP process, the OMI launched the Via pilot. Things ran much smoothly given the OMI's lessons learned from *Night Shift*. Reviews were mostly positive—this service was far simpler and more generous than *Night Shift*. The OMI still went through their normal feedback process, and conducted 50 interviews to suss out barriers to entry. They expected the high unbanked population to be the biggest barrier, and were prepared to implement the best practice of prepaid debit cards learned from Via pilots in other areas with high unbanked populations. They found that the biggest issue was more so worries about sharing a ride or riding in somebody else's vehicle during the pandemic. The OMI iterated on the pilot to add more signage for capacity limits and cleaning in between trips, which helped reduce those fears and build trust.

As of December 2020, the OMI is working to extend the current contract for another year, and expand the audience to not just essential employees but also the broader public, targeting Northwest Detroit. In another addition, the OMI is working to expand the Ride United pilot with United way. Though the HCD pipeline for *Night Shift* was interrupted by the COVID-19 pandemic, the piloting lessons learned were well documented and stuck around to feed into other separate iterations, far from a "one and done" endeavor.

5.3.4 Key ideas

Trust: With Detroit and many other places' long history of Black people getting taken advantage of, trust of public sector programs is a major barrier to mobility pilots. Making sure customers talk to real people, and iterative feedback can help ease this mistrust.

Feedback iteration: The biggest tenet of HCD is that stakeholder feedback and iteration are key to ultimately reaching "successful" pilots. For the OMI, this means making sure to call every single person using pilot services and improving the service every couple of months.

Agile/Lean: The OMI emphasized an iterative, nimble approach to piloting—the faster something gets out, the faster that feedback can be used to make things better. This caused frictions with the existing institutional configuration of the City of Detroit's departments (e.g. long procurement processes), and lead to reliance on nonprofit fiduciaries for flexibility.

Learning: The OMI emphasizes "lessons learned" from specific pilot hypotheses to broader lessons on engagement, marketing, funding, and piloting processes. They also try to document their processes well—taking advantage of today's tools like Google Docs to build organizational capacity and resilience to employee turnover.

Incrementalism/pragmatism: "We're not always going to be able to provide a TNC credit through long-term government funding, but there might be grants to help for specific use cases." Though controversial, limited scoping is often necessary to amass the grant funding to make any interventions in the space, often more favorable than waiting for catchall silver-bullet solutions.

5.3.5 Lessons for the future

1. Meaningful and well-documented reflection and feedback from experiments is one way of accountable "evaluation", even without statistical rigor or quantitative data.[94]
2. Pilots driven by top-down leadership are dangerous and subject to political power that often erases community voices, but can also meet residents' needs, with limitations.
3. "Done is better than perfect", and in places where transportation is stuck in decades-old institutionalized practices, messy small-scale initiatives[95] can plant the seeds of change.

5.4 Discussion

Comparing across case studies can yield new understandings. First though, it is important to see how they line up with the definition of urban experimentation from Chapter 4 (Table 5.2).

[94] For experimenters, "Take steps to control the first stage of the customer experience so you can follow up with and track customer experience on your own terms without relying on benevolence from the private sector to share data."

[95] In essence, *jugaad*, a colloquial Hindi/Bengali/Marathi/Punjabi/Sindhi/Urdu word for creative, non-conventional, frugal innovation. Often termed "hacking" in MIT and US culture.

Table 5.2 - Do the case studies fit within the specified definition of urban experimentation?

Defining Features	*EZ Ride*	*refleX*	*Night Shift*
6. *Intentional intervention in the urban environment*	✓	✓	✓
7. *Explicitly limited in scale— in space and/or time*	Two-year funding for coordinating within DATC.	Three-year funding for two transit corridors.	Limited to 2000 rides within a specific service area.
8. *Challenges the status quo*	*Technical*: New ASDS to expand capacity and reduce deadheading. *Institutional*: Coordination between community services.	*Technical*: New, well-branded express service to better serve needs. *Institutional*: City-suburb collaboration.	*Technical*: New first-mile/last-mile service using TNC's. *Institutional*: New relationships between TNC's and gov't. Agile vs. "slow government".
9. *Claims of learning*	Though small, claimed to learn if coordination would be successful and lead to higher demand	Sought to prove if simplicity and branding would be effective.	Rigorous HCD framework for testing hypotheses.
10. *Actuality*	✓	✓	✓

Given that all of the cases can commonly be called "urban experimentation", both variation and similarity between them becomes the crux of comparative work, discussed in the following sections.

5.4.1 Technical comparisons

Motivation: Each case was motivated by the ever-present regional need for better access. They varied on which populations they were serving, and what factors pushed for their actual implementation. *EZ Ride* was motivated by federal funding and the EZ's concerted effort towards Detroit's Renaissance. *refleX* was motivated by the energy of transit planners who were dissatisfied with the status quo of their jobs. *Night Shift* was largely motivated by Mayor Duggan's agenda and pressure from the Smart Cities Challenge. Common amongst all of these was federal or philanthropic funding opportunities which often did not cover the whole cost of the experiment, but sparked momentum for effort and could be leveraged to attract additional investment.

Scale: Spatially, *EZ Ride* and *Night Shift* were focused on the City of Detroit, while *refleX* was explicitly repudiating regional divides. Financially and practically, *Night Shift* was the smallest pilot, serving only 2,000 rides over two years, what on the surface would cost $140K. *EZ Ride* was the next biggest, with a $300K ASDS system supporting a $3M/year transportation service with over 100,000 rides/year. *refleX* was a new, $5.6M/year service with around 400,000 rides/year. Despite the orders of magnitude differences in scale, they were all drops in a bucket in meeting their respective targeted needs. Politically, each case occupied a middle ground—small enough to elide large scale public discourse or direct intervention by the region's topmost political actors, but large enough to attract attention of those targeted and involved. *refleX*'s larger scale did, however, lead to collaboration between

multimillion-dollar budget transit agencies, though was an incremental approach to confronting politics at the regional scale, while *EZ Ride* and *Night Shift* were confined to local political dynamics.

Timeline: Each pilot invested a significant amount of time into planning and procurement stages—often half the amount of time allotted for actual implementation. Longer timeframes led to decreased potential for iteration—most drastically, *EZ Ride*'s implementation was stuck in procurement processes for years, and left little time to expand the pilot before the whole operation shut down due to the recession. Lag times for customer adoption on the order of a couple months was also important in *refleX* and *Night Shift* where careful marketing strategy was key. *Night Shift*'s accelerated timelines and smaller scale allowed for more iteration and feedback processes rooted in user voices.

Evaluation: Only *Night Shift* executed a formal evaluation through U-M Poverty Solutions, which was limited due to data sharing constraints. Much more important for all three pilots was the informal monitoring of the experiment. Ridership numbers were roughly tracked for *EZ Ride*, enough to prove that the ASDS was very helpful for increasing capacity. Neil checked the numbers constantly on *refleX* ridership, while talking with actual people and experiencing the service for himself. *Night Shift* made many phone interviews to qualitatively understand barriers and how to iterate next. Documentation and internal slide decks helped these lessons stick. Informal but accountable evaluation here allowed for feedback for iteration rather than one-off pilot-evaluation processes.

5.4.2 Actors involved

Designers: Ideation varied from large community-based meetings with many nonprofits (*EZ Ride)* to top-down idea generation with varying amounts of feedback (*refleX* and *Night Shift)*. Though large community forums may be prohibitively time intensive and necessitate large followings, the OMI's emphasis on stakeholder feedback can be seen as a targeted effort to design experiments while including community voices.

Funders: *EZ Ride* and *Night Shift* were funded by the same mix of philanthropy, federal funding, and some private sector involvement. *refleX* was funded through the separate transit funding apparatus—federal, state, and local funding funneled through an institutionalized flow. Though funding through grant programs is often pitched as separate from implementation or design, funders often have the privilege of initial stage setting through problem definition (*Night Shift*) and deciding who gets a seat at the table (*EZ Ride)*.

Implementers: Experiments cannot survive in the real world without informal supports from implementers and a "let's make this work" attitude. Even the most technically framed experiments are accommodated by tacit manual fixes (*EZ Ride)*, robust organizational communication (*refleX*), or above and beyond feedback processes (*Night Shift*). Upon investigating pilots as a "process" in this way, all case studies uncover underrecognized sites of agency within the literature—if an experiment's actuality relies on implementer support, then they must have substantial influence.

5.4.3 Performance and marketing

Customer experience: *refleX*'s team was fairly certain that customer experience was a key barrier to *refleX*'s use, and sought to prove it. *Night Shift* learned this importance iteratively, and robust feedback processes allowed them to tailor the service beyond just generalizable customer experience improvements. Subsequent iterations to publicize through employers led to significantly higher

adoption. *EZ Ride* aimed to help the customer by consolidating different community transportation service providers into one phone number, but its vision did not ultimately come to fruition.

Performative legitimacy: *Night Shift* had some evidence of the classic example of performative legitimacy—Lyft benefited from some positive press releases that pushed a benevolent and modern reputation, attracting more riders in a self-reinforcing cycle. *EZ Ride* added to the MAC's reported accomplishments since its inception[96], which was helpful in activating funding sources to further support the pilot efforts, but also fed its business lobbying endeavors. *refleX* boosted perceptions of the RTA, SMART, and DDOT, and aimed to further legitimize regional transit service. The variation in legitimation shows that though private sector capture is a useful lens to interpret experiments, it is not the full picture.

5.4.4 Institutional change

Political context: This thesis argues that experiments can be interpreted as open-ended institutional change. This is most apparent when an experiment explicitly/implicitly questions dominant politics and power relations. *EZ Ride* was a unique intersection of federal, regional, city actors listening to nonprofit community interests. *refleX* questioned the city-suburb divided status quo. *Night Shift* pushed back on public mistrust of city programs by trying to flatten decision-making structures.

Coordination: One major mechanism of institutional change is by strengthening new coalitions of actors. Experimentation is an incremental way of doing this— venturing into uncertainty requires adaptation of existing coalitions. This can be explicit, as in *EZ Ride* or *refleX*, or more implicit, as in *Night Shift*'s forming of new tech-government-philanthropy coalitions.

Learning: Experiments build *capacity*, or learning about how to "get things done" more easily. Lengthy documentation and reflection distinguished *Night Shift* from the other cases, and allowed generalizable lessons to extend beyond employee turnover. For *EZ Ride* or *refleX*, as the pilot champions moved on from the initiatives, so did many of the positive lessons and capacity of organizations.

5.5 Conclusions

These case studies illustrate the benefits of considering urban experimentation as open-ended institutional change. I expand upon the four major academic conceptions of urban experimentation outlined in Chapter 4.

All urban experimentation is performative, in the sense that all experimentation *acts* in material and social worlds; all experimentation is *planning*. Outside the classic explanations of bolstering legitimacy or creating self-fulfilling prophecies, I argue that the ways urban experimentation can act include destabilizing the social construction and stability of institutions and planting the seeds of change. Experimentation is a key site where grounded practitioners (e.g. "Team refleX") or communities (e.g. the CBMS) whose voices are usually disregarded can enact long-sought "systemic change". Borrowing from

[96] And is still there, not acknowledging that the system has been out of service for almost ten years. Upon correspondence, MAC employees have understandably lost track of the pilot's status. See https://mac.semcog.org/Accomplishments.

Butler (Kotz 1992)[97], I argue that existing power relations do influence but are not fully determining of experimentation processes. Compared with other forms of transportation planning—long-term deployments, large scale ballot measures, long-range planning processes—urban experimentation opens up a concentrated space of potential change to power relations and institutional networks.

Key mechanisms for this institutional change highlighted by the case studies include: 1) the strengthening of new coalitions, and 2) capacity building. In this, pilots are "learning", as in the scientific and policy-rational frameworks in Chapter 4, but much less so trying to answer questions of the objective external world, but rather learning about internal processes through an emergent process. Learning here embodies the same sites of agency without a steadfast commitment to objectivity.

In creating new coalitions, in contrast to the devolution and fragmentation that the harbingers of neoliberalism purport, the examples in these case studies include unprecedented coordination and are often a product of messy state-corporate relationships. The necessities of competition and the drive for progress motivate all of the cases, but do not necessitate an adherence to free market principles. Political economic institutions are thus extremely important to consider, but are also not fully determining of urban experimentation.

Further theoretical development of "how institutions change" is out of scope for this thesis, but these case studies do highlight two specific mechanisms of change and result in four useful practical lessons:

1. **More qualitative data and formalized evaluation is useful but not necessary. General accountability and documentation are much more important. Informal, qualitative evaluation can be extremely helpful and easy.**
2. **Perception matters— experimenters need to play the marketing game or risk their pilots never getting off of the ground.**
3. **Who is *doing* experimentation has agency to affect outcomes, but is limited by funders and initial experiment and problem setting.**
4. **Urban experimentation is one way that transportation becomes a site of political possibility. New coalitions and capacity building can trickle further to long-sought systemic change.**

[97] Butler argues that gender being performative does not mean pure voluntarism (e.g. "I can get up in the morning and decide what gender I want to be today"), but also does not mean full determinism due to power relations. Repetition of small acts is how true subversion happens.

Chapter 6: Conclusion and Reflections

6.1 Summary

This thesis provides a deep dive into unturned stones of SE Michigan's urban mobility regime, with insights for transportation planning and beyond with considerations of knowledge and power. Taking accessibility as the major outcome of interest, both parts chart underrecognized routes to realizing more just outcomes.

Part 1 outlines insights from the creation of a collaborative accessibility tool. Typical transportation planning practice is excessively technocratic, misguidedly maximizes mobility rather than accessibility, and uses outdated and overly sophisticated tools that feeds this dominant paradigm. Current efforts at changing the game using accessibility analysis are either nonexistent or ironically inaccessible to nonprofessional audiences.

Using the latest public data, open-source analysis software, and free tiers of web development tools, I created a simple but engaging accessibility visualization, emphasizing iterative feedback in a collaborative process. It updates and validates academic literature and highlights the stark side-by-side inequality of accessibility in the region, disproportionately affecting Black and low-income people and concentrated in the city of Detroit. It highlights the need for regional coordination and large-scale accessibility improvements, which may start to be addressed by recent initiatives around regional transit.

Those who used to tool found it enlightening with a well-crafted look that was inviting to unfamiliar users, something only enabled by the latest user interface libraries. Through the process, however, it was clear that recreating such a tool in other contexts would require large time investment and leveraging a scattered but robust online community for technical support. Outreach to spur the feedback process itself is also a substantial piece of work, and often dictates success. Treading the path once, proving the worth of the concept, and maintaining clear open-source documentation is helpful for those who might want to follow suit. Doing so can start to chip away at the dominant perceptions of transportation and support a fresh emphasis on justice in the discourse.

Part 2 is an examination of urban experimentation in the region. Urban experimentation is often thought of as just finding technical solutions to urban problems, whether it be through new technologies or "best practice" regulations. Critics argue that urban experimentation is more often a performance by private companies or governments to boost their own reputations. The most incisive academic critiques relate urban experimentation to a broader splintering of coordinated action into fragmented competitive landscape. In doing so, urban experimentation is another part of global trends of neoliberalization that are configured and exploited by a capitalist elite. Through three deep case studies of urban experimentation with transportation in the region, I outline how the above conceptions unnecessarily place stakes on opposing poles of a trialectic, one side overemphasizing knowledge and another side power.

The first case study is of *EZ Ride*, a technologically enabled coordination of community-based transportation services in the Empowerment Zone era of the early 2000's. It tells the story of nonprofits on the margins, surviving from grant-to-grant within unideal funding cycles and unable to build up capital assets or capacity to run more efficiently. The small-scale pilot was not so much a laboratory test

for a large-scale truth, but rather a performative seed to attract other funding sources for a period of stable finances and growing organizational capacity.

The second case study is of *refleX*, a city-suburb collaboration for a well-marketed limited-stop express bus service after the recession recovery around 2016. It tells the story of the region's two major bus agencies, SMART in the suburbs and DDOT in the city, and how a motivated A-team overcame a decades long city-suburb divide between the agencies. By evading a grandiose agency merger and focusing on coordination on just two regional lines, they were able to create and strengthen a lasting interagency coalition that carried into future route redesigns and much awaited fare integration. Though *refleX* was a well-branded and marketed pilot project, a usual indication of cooptation by powerful actors, it largely elided direct intervention by the region's topmost political actors and advanced the goals of transit planners grounded in rider experience.

The third case study is of *Night Shift*, a public-private partnership that provided $7 ride hailing credits to supplement late night bus service, executed by City of Detroit's new Office of Mobility Innovation from 2018 to 2020. Though pushed in a top-down fashion by powerful philanthropic actors and the Mayor, *Night Shift* relied on a human-centered design process focused on feedback and iteration which allowed implementers to also fulfill some disadvantaged residents' needs. Comprehensive documentation of lessons learned allowed for quick capacity building that led to much quicker and more effective rollout of subsequent efforts, such as a Via pilot for essential workers in the pandemic.

The case studies underscore that the outcomes of urban experimentation are much more open ended—urban experimentation is a site of concentrated political possibility without technical scale that can often be more open to bottom-up actors. In response to the above conceptions of urban experimentation: quantitative data and formalized evaluation are not as important as general accountability, perception and marketing is important to get any experiment off the ground, and implementers themselves have agency to shape outcomes outside of funders and initial decisionmakers. Through building new coalitions and building capacity, urban experiments can trickle further to long-sought systemic change in transportation and other fields.

6.2 Conclusion

This thesis links concrete examples with some ways that an urban mobility regime can change:

1. Highlighting non-dominant representations of space in the discourse, and as a result uplifting alternative forms of knowledge and actors that can participate in planning.
2. Creating and supporting new coalitions of actors to destabilize the network of power relations that underlie the current urban mobility regime shape its accessibility outcomes.
3. Building organizational capacity (e.g. reflexive knowledge of bureaucratic, social, political, or material considerations) via "learning by doing" to reorder power relations and allow for increased capacity for planning in new places.

Importantly, these mechanisms of change are often more open to use by bottom-up initiatives. Analogously, protesting dominant narratives, organizing co-conspirators, and learning to respond to immediate community needs have all been staples of grassroots work. Whether through a collaborative web tool or through government-sanctioned urban experimentation under a technological guise, these are mechanisms that can be leveraged by all in striving for a more mobile and just future.

6.3 Reflections on Theory and Practice Going Forward

The analytical framework created in Chapter 1 of planning, knowledge, and power arises from a theory of institutions, or "rules of the game". While institutional theories have largely sought to explain stability amidst contradiction in society, theorists have increasingly paid attention to how institutions *change* to satisfy a practical goal of "what to do next". However, these scholars have too often focused on intangible distinctions underlying personal theories of change: continuous change vs. critical junctures, gradual change vs. punctuated equilibrium, endogenous vs. exogenous, adaptive vs. disruptive, etc. Much less often do institutional theorists articulate the real and experienced mechanisms by which these institutions change in an understandable way (Streeck and Thelen 2005). This squanders the potential for actionable insights from this powerful analytic lens.

This thesis identified three concrete mechanisms of institutional change. First, vocalizing non-dominant perceptions in a discourse is a first step in destabilizing a status quo. In this case, forwarding non-dominant representations of space allows for countervailing forces in space's social production. Second, supporting new coalitions can reconfigure existing networks of power relations, and urban experimentation often explicitly creates the conditions for coordination. Lastly, bolstering individual and collective capacity for intervention can reorder power relations and boost sidelined actors through knowledge not only of the material world, but also of social and political context. Urban experimentation gives organizations the opportunity to "learn by doing" and attract support. What these examples make clear is transportation work goes beyond just changing the material world, but also plays an important part in institutional development and the production of space that underlies our social and political existence.

Perhaps this granular and narrow-focused study was advantaged by the informal quasi-academic context in which a Master's thesis resides. The opportunity to engage with humble artifacts, build deeper relationships with interviewees, and appreciate the "muddling through" of actually existing and constantly contested transportation practice has brought color and relatability to the work and its results. The freedom to engage with epistemic questions such as overdetermination, the structure-agency dialectic, and contradiction without an obligation to formalized objectivity has allowed for analysis outside of neatly prescribed frameworks (Dewar et al. 2015; Lowe 2020). If anything, through this thesis I would argue methodologically for an increased engagement with the everyday in conjunction with an academic commitment to advancing justice (Leitner, Sheppard, and Peck 2020).

Those doing the work have much ability to shape how it gets done. As the professionals who make their livings creating long-term plans, charting bus schedules, implementing pilot projects, pushing funding policies, etc., policymakers and practitioners navigate a middle-ground between accommodating funders or political actors and serving the public. Small changes in the format of community engagement, publicization of data and analyses, or documentation of decision-making processes can lead to meaningful beginnings of change. Branding and web user interfaces can be done more easily once initial processes are set, and are often major hurdles for transit systems that rely on riders "inheriting" their knowledge of how to use the system.

More generally, transportation planning and policymaking usually relies on abstracted metrics in decision-making processes, which excludes many community members who do not understand the language. Changing the way transportation data is visualized is one potential route towards mitigating this dangerous abstraction. These more grounded visualizations can better match on-the-ground

experience and make clear that improving bread and butter transit service indeed makes scalable regional advances in accessibility. Interventions that are not complementary to this goal merit considerable reflection.

Lastly, policymakers and practitioners are in the unique position of shaping the grounds of urban experimentation. They are often creators of grant programs that fuel initiatives, or are the ones themselves carrying pilots through. They can direct pilots to addressing historically rooted racial and economic injustices through explicit equity mandates within mobility pilot RFP's or grant opportunities (Fedorowicz, Bramhall, and Ezike 2020). They also have a responsibility to leave communities better than before and flatten the experimenter-experimented power dynamic. There are many ways that policymakers and practitioners have agency to shape outcomes, and recognizing that is one step towards meaningful change.

For the readers who stumbled upon this thesis out of curiosity and are unfamiliar with the jargon, frameworks, and perspectives used throughout— I first hope to highlight the importance of mobility justice in all our lives. Transportation is how we get around to the grocery store, doctor's offices, schools, jobs, loved ones, or anything else that's helpful for just living a life in this connected world. Outside of our own ability to get where we need to go, we depend on each other's ability to do so as well. The COVID-19 pandemic has highlighted this with the new distinction of "essential workers" as those who keep society running. Safe and affordable transit is often essential to essential workers, and thus to us all. The Black Lives Matter movement has further shown the stakes for safe and affordable transportation for Black people, whose personal mobility has been historically limited through decades of racist policies.[98] In contrast to prophecies of a future where we all work from home, this past year beckons us to reflect on how doing so is not a universal privilege.

Next, I hope to impart a sense of agency by highlighting concrete ways that we can act. Advocates have long known the truths about mobility injustices, and have lent their voices in spreading the message. Adding our own voice, networks, and capabilities to these existing efforts is straightforward way of getting involved. But the power of protest is not limited to taking to the streets and being heard. Taking control of open source digital tools can show injustices in new lights, potentially engaging wider followings. Organizing new coalitions with others or well-documented learning by doing are other ways of start to shift the rules of the game. This power of protest is how we can start hacking away at the seemingly immutable systems that perpetuate injustice in mobility and beyond. Utilizing these tools in fighting for a future of free and fair movement is imperative as we seek to improve opportunity for all.

[98] See the articles in this series on race, equity, and public transit in America: Tamika Butler. "To tackle pandemic racism, we need to take action, not just take to social media". *Urban Edge*. The Kinder Institute for Urban Research at Rice University. Sep. 14, 2020. https://kinder.rice.edu/urbanedge/2020/09/14/transportation-transit-tackle-pandemic-racism-we-need-take-action-not-just-take-social-media. For the SE Michigan case see Glynn, Shen, and Goetz (2020)

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