When Life gives you Limes: Integrating New Modes of Mobility into Existing Transportation Landscapes

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

Advisor

Kathryn A. Neeley, Associate Professor of STS, Department of Engineering and Society

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Introduction

Communities across the U.S. and the globe are experiencing friction in integrating a new form of mobility, shared dockless e-scooters, into their transportation options in a safe, equitable, and efficient manner. (Lazo, 2018) This difficulty partly stems from how rapid e-scooters have grown in popularity versus the speed at which transportation infrastructure can adapt. (Grand View Research, 2020) (Zagorskas & Burinskiene, 2020). For the moment, integrating e-scooters into the existing infrastructure is the option that makes the most sense given the rapid pace needed to adapt and limited monetary and political funds available.

We don't currently know what precise rules and guidelines community leaders and residents alike can use to integrate new modes of transportation like e-scooters. We can start by defining what questions policy makers need to ask about who benefits, who is disaffected, and how to negotiate between the two on a solution that is in everyone's best interest. We know that the introduction of cars created friction for bikes and pedestrians, but what about introducing a new form of micromobility, or "forms of transport that can occupy space alongside bicycles." (Zarif, Pankratz, & Kelman, 2019)

When cities ignore the issue of e-scooters and let the private companies operate without rules, many stakeholders are affected. From riders who must have 4+ scooter apps on hand ready to go, sidewalk users blocked in their path by scooters not left in their places, or cars and other bikes on the road that are unsure of how to maneuver around a scooter safely, there are considerable safety consequences to letting scooters run amok. On the other side, if cities decide to wholly ban e-scooters, they could be missing out on an opportunity to have more diverse

transportation options, some might be more efficient and fun for riders, and environmentally friendlier. (Jiao & Dillivan, 2013) (Hollingsworth, Copeland, & Johnson, 2019)

I will go about answering the research question of what rules and forms of conduct are necessary to introduce new forms of mobility in American cities by conducting a cross cultural documentary analysis on the topic of e-scooter introductions. These documents include public city council meetings, city government reports, community member discourse, and documents from the private e-scooter companies. Analyzing recent past introductions of e-scooters and studying what about those integrations made them successful or not successful will uncover guidelines that can be used in the future not only for other cities looking to adopt e-scooters, but also if there are entirely new modes of transit on the horizon. The similarities and differences between each of the introductions across San Francisco and Charlottesville will help me outline what frameworks cities can use to evaluate whether e-scooters would be beneficial, and how to successfully deploy them.

Analyzing these historical introductions through the frameworks of engineering as social experimentation (ESE) (Martin & Schinzinger, 2010) will illuminate how engineers, policymakers and residents can find common ground toward a smoother introduction of shared dockless e-scooters. In this paper, I argue that adhering to principles informed consent and organization and explicit responsibility will increase the likelihood of successful introduction of new modes of transportation.

Supporting Argument #1: Problem Frame. What are these scooters doing here anyway?

When city authorities play an active role in approving new additions to infrastructure, they can screen for safety hazards and ill consequences. While that is beneficial, the amount of time required to evaluate and approve proposals can be frustrating for residents and private companies seeking to introduce their solutions. As more residents have access to internet connected mobile devices, they utilize and benefit from having their transportation planning just taps away. This freedom can help cities with employment and quality of life improvements with increases in mobility. (Smith & Schwieterman, 2018) Local governments can work with private companies to evaluate pilot programs introducing e-scooters. Charlottesville is currently in the process, and many others are currently in or have completed them such as Portland, OR and San Francisco, CA. (Portland Bureau of Transportation, 2018) While there are many other cities grappling with similar frictions, (Sabin, 2019) focusing on these two should provide an informative sample as they each have unique backgrounds and perspectives regarding the scooters.

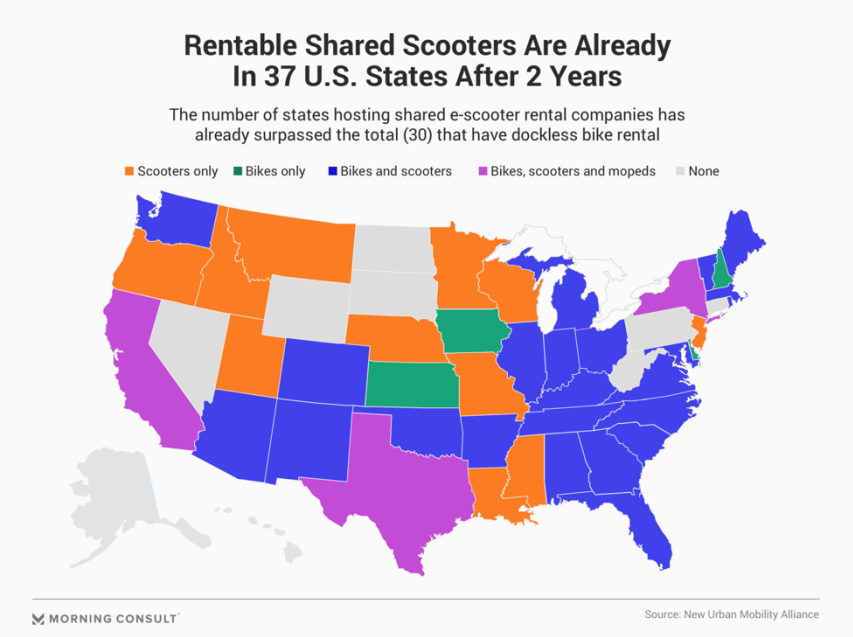

Figure 1: Map of Introductions of Micromobility in the U.S. as of December 2019. Shows the distribution and prevalence of multiple forms of mobility.

There are numerous studies on transport economy, the study of the movement of people and goods over space and time. There are debates surrounding this topic on open market structures, where private companies like Lime or Bird operate, versus centralized structures where local governments are in charge of operations. (UNESCO, 1991, p. 84) The case study of e-scooters in Charlottesville is a dynamic intersection, as the majority of operations and logistics are handled by private companies, but there are rules and regulations they must follow set in place by the city of Charlottesville governing where and how many scooters and dockless e-bikes must be distributed to remain in service. (City of Charlottesville, Virginia, 2020)

What this research seeks to understand are questions like what are the best criterion to evaluate success of new modes of transportation? How can leaders, residents, and companies' best interests be aligned toward a common goal? What new rules should residents know about in interacting with e-scooters, whether as a driver, cyclist, pedestrian or riders?

This STS research will build upon Mesthene's research on understanding the impact, both positive and negative, that technological change has on humans and society. (Mesthene, 1970) Mesthene's work begins by expressing the inadequacies in viewing changes as wholly beneficial, or wholly detrimental to the present societal frameworks, instead of arguing that there is value in calling to question the goals of society when disruptive changes are occurring. Mesthene's research bolsters the ability to have a sound understanding of the nuances and tradeoffs regarding a given change in available technology, in this case, e-scooters.

Additionally, this research highlights the role of engineers as technological mediators, as Downey does in his work (Downey, 2005). Rather than having advancements and new mobility modes introduced without considerations of all stakeholders, the enumeration of rules and guidelines for all stakeholders will help to integrate e-scooters or other micromobility modes into

existing transportation landscapes. Describing both the problems e-scooters could solve, and the problems they create concerning as many stakeholders as possible can help to arrive at a common solution, even if stakeholders view and describe the problems differently.

While engineers must serve as technological mediators, Martin & Schinzinger argue that engineering can be thought of through a framework of social experimentation. A source of knowledge and analysis is Martin & Schinzinger's Engineering as Social Experimentation chapter. (Martin & Schinzinger, 2010). Their claim, Murphy's Law, that "if anything can go wrong, it will-sooner or later" highlights the constant risk involved with engineering work. There are numerous risks to different stakeholders in a scooter scenario. There are riders who should be aware of the inherent risks of riding a scooter, especially without proper head protection (cite how many rides without a helmet. There are also drivers and other pedestrians who might be put in harm's way either by scooter riders or parked scooters while they try to reach their destinations. Another key aspect of Martin & Schinzinger's work is the discussion on informed consent. Having a strong framework for what constitutes informed consent with regards to engineering as social experimentation sharpens the rules for the responsibilities that scooter companies, local and state governments, and residents each have. This paper will build upon the principles of knowledge and voluntariness in applying them to the case of e-scooter integration.

Lastly, this paper will expand on the analyses of diffusion of responsibility, and differences between negligence and malice. Studying the various cities that have encountered the e-scooter trend reveals there is a spectrum of possible actions that both cities and e-scooter companies can take. The danger is most prominent when either party assumes that responsibilities fall on the other. Residents and scooter companies alike would benefit from the

ability to distinguish between negligence and malice, as the latter creates steeper hostilities between stakeholders.

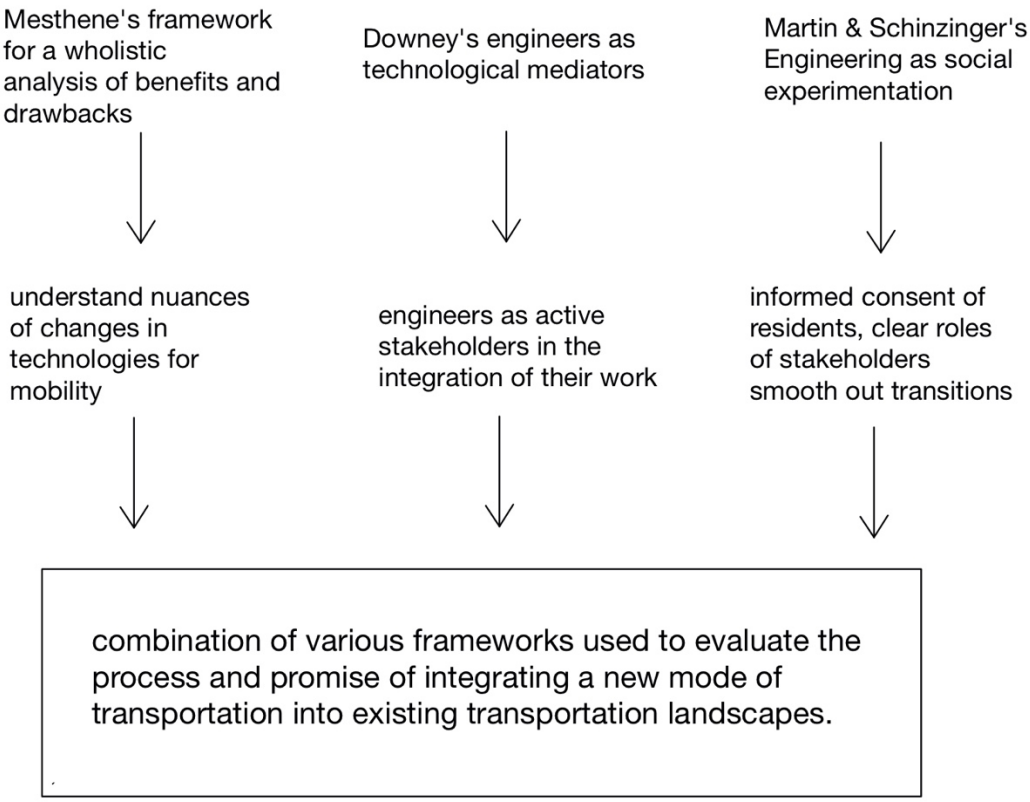

Figure 2: Flowchart organizing what each framework offers to the research question.

There has been considerable research and progress in understanding what roles engineers have the responsibility to occupy as shown above. But there is less research in understanding where groups of engineers, city councils, residents overlap, and the rules that help mediate between those stakeholders. Understanding the perspectives of each party: residents, community leaders, and e-scooter companies can help to articulate strategies of mediation that each can take to improve the chance of success in integrating e-scooters into transportation landscapes.

Supporting Argument #2: Methods. Scooting from problems to strategies

Technical and governmental documents can serve as evidence for cross-cultural analysis, as shown in Bijker's analysis of Dutch and American authoritative engineering papers on flood control systems. (Bijker W. E., 2007). By comparing conference papers from American and Dutch engineers and showing a difference in content regarding conception of risk management, he was successful in showing a difference broader national cultures stemming from differences in geography and role of state. Beyond broader cultural differences, he makes sure to delineate that the differences were also in wider technological cultures rather than in specific engineering cultures. He describes today's societies as "thoroughly technological and all technologies are pervasively cultural." (Bijker W. , 2009, p. 67) This view on the interconnectedness of society and technology supports further analysis on other shifts in technology, specifically in new modes of transportation, as transportation is both shaped by the surrounding cultures (U.S. car centric mentality) and the available technology (lithium-ion batteries).

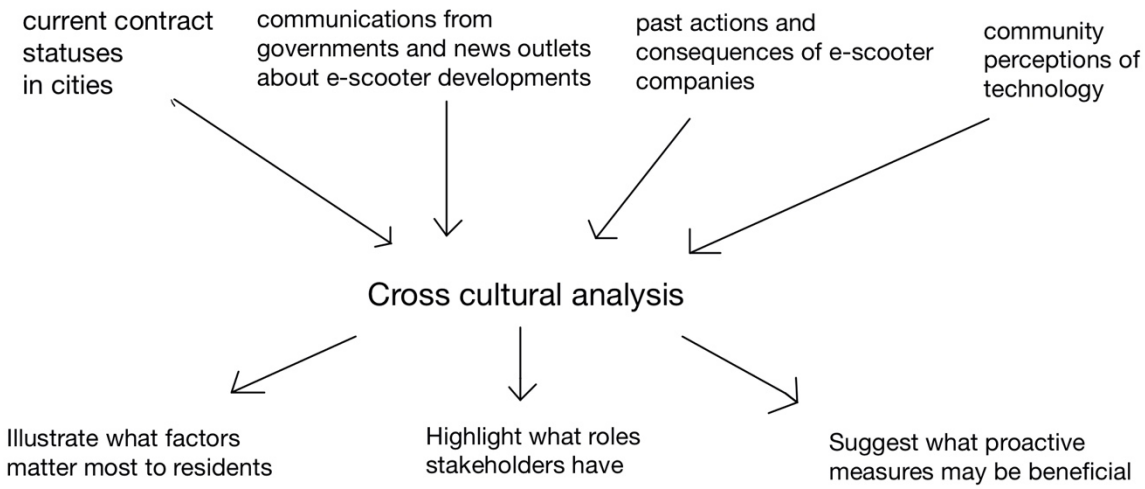

Figure 3: Cross cultural analysis flowchart of information to findings.

In their chapter on Engineering as Social Experimentation, Martin and Schinzinger argue that "engineering is an experiment on a social scale involving human subjects." (Martin & Schinzinger, 2010, p. 78) The authors contrast engineering with traditional lab experiments in a few key points: experimental control, informed consent comprised of knowledge and voluntariness. In engineering, rather than science in a lab, it is impossible to have proper experimental control groups, fully inform subjects (customers or citizens using engineering systems) of the risks. (Martin & Schinzinger, 2010, pp. 83-84) Further in the chapter, the authors list four characteristics of responsible engineers: conscientiousness, comprehensive perspective, moral autonomy, and accountability. These four characteristics combined with the differences to lab science experiments serve as key factors to notice in analyzing evidence.

To find out what differences between select cities' introductions of dockless e-scooters determined the success of the transition, it is useful to analyze governmental documents, public discourse, and materials from private e-scooter companies in similar fashion to Bijker. Searching for presence or absence of the four characteristics of responsible engineering, as well attempts to achieve informed consent and experimental control groups in these documents serves to solve the question of what rules (written or unwritten) stakeholders must agree to in order to have a successful integration of a new mode of transportation.

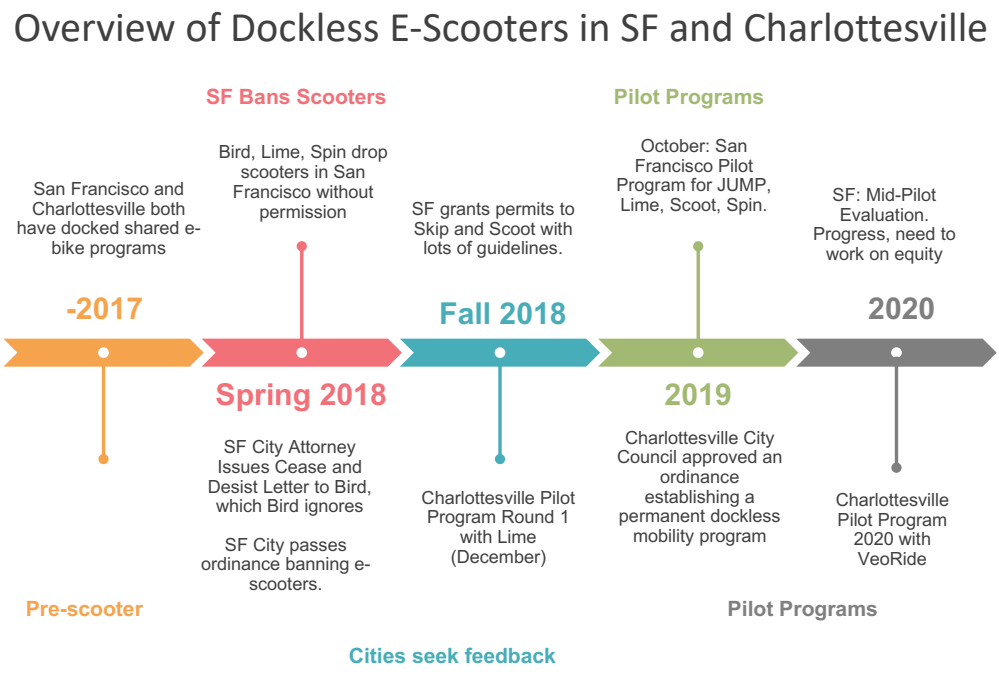

Figure 4: Timeline representing the developments of e-scooters in Charlottesville and San Francisco.

The timeline highlights some key facets of engineering as social experimentation framework. First, Charlottesville was able to learn from the mistakes and tensions between scooter companies operating in San Francisco and the city government since San Francisco was an earlier starting place for scooter companies. Learning from the mistakes reflects how even when engineers and policymakers can't orchestrate controlled experiments with test and control groups, they can, however, build upon prior experiences similar to how scientists build upon past experiments in their field. But in order for the transfer of knowledge to be successful, there need to be robust communications to reference. The increased public feedback via social media also

helps cities that might be considering adopting new technologies like dockless e-scooters by providing an efficient medium for discourse.

Second, this timeline also shows the negative consequences of lack of informed consent versus efforts to inform the community before making decisions that can affect mobility and safety. San Francisco's cease and desist letter, followed by a formal ban after scooter companies dropped their vehicles in the city (without consent or warning) is a non-example of forward-thinking communication between engineers, scooter companies and who their products ultimately affect. Charlottesville benefitted from gathering public opinion from the decision to begin the pilot program in the first place, and throughout the pilot program even to today. (Robinson, 2019) Both the representatives of scooter companies and city authority demonstrated conscientiousness in Charlottesville by placing emphasis on equitable access to scooters, incorporating rules into the permit rules from the start. (Robinson, 2019) The timeline shows how even when San Francisco had an earlier introduction to shared dockless e-scooters, their pilot programs started to take place around the same period as Charlottesville and seem to have a more productive start to incorporating e-scooters into their transportation ecosystem.

	Charlottesville	San Francisco
Prior experience with tech	"Cornerstones not of a tech or shareholder economy, but a purpose economy." (Kluge, 2016)	Most respondents see the tech boom as most strongly helping tech executives and workers, not all other residents. (Cagle, 2013) News outlet refers to "typical tech arrogance." (Bhattacharjee, 2018)
Supporting Documents from Municipal Governments	City of Charlottesville website gives information on how to use e-scooter, equity programs, and ways to contact operators and	Cease and desist letter to Bird from District Attorney. (Bhattacharjee, 2018)

	city officials. (City of Charlottesville, Virginia, 2020)	SF MTA Report: Pilot program progressing fine, but still need to work on equity. (San Francisco Municipal Transportation Agency, 2019)
Scooter companies complying/rebuking rules.	Lime and Bird in first round of pilot. Neither stayed but did follow rules of the permit regulation. (Mckenzie & Stout, 2019) Only current contract is VeoRide. (City of Charlottesville, Virginia, 2020)	Bird, Lime, and Skip released scooters without city permission. Bird disregarded cease and desist letter from city attorney. SF passed law in response. (Said & Sernoffsky, 2018)
Community members response	"It's exciting for Charlottesville" - Community resident. (Smith & Wrabel, 2019)	"They've kind of behaved like a bunch of spoiled brats," said Aaron Peskin. (Utehs, 2018)

Figure 6: Table summarizing documentary and discourse surrounding introduction of e-scooters in three cities: Charlottesville and San Francisco. Shows the breadth and variation in response from municipal governments, community members, and e-scooter companies.

As shown in the table above, the approach and response to the introduction of e-scooters is distributed among many stakeholders, making engineer's role as technological mediators complex and at times, unsuccessful. Understanding the differences in approach and consequently the varying successes or rejections among different cities will show how overlap in responsibility and cooperation and agreement on strategies amongst all stakeholders can determine the success of introducing a new form of mobility.

Supporting Argument #3: Results

Communities' prior experiences with technology matter

San Francisco's community had a different predisposition to technology from the negative effects of having major software and hardware technologies headquartered in the city

and surrounding area. A news article reporting on the status of culture cited "typical tech arrogance" (Bhattacharjee, 2018) in response to the SF City Attorney's cease and desist letters to scooter companies. Charlottesville has a budding startup scene as well, but the discussions surrounding it seem more optimistic, with a Forbes article highlighting how there are "cornerstones not of a tech or shareholder economy, but a purpose economy." (Kluge, 2016) The rosier outlook on the promise of technology is because of lack of past exposure or because of a more intentional fostering of an inclusive and productive tech culture. However, Charlottesville residents seem to have a more open mindset to investigating new promises of innovation, as shown by the annual TomTom Founders Festival, Civic Innovation Meetups, and other events meant to unify various individuals and companies together around driving meaningful and impactful innovation. Residents' prior experience with technology is critical because previous experiences bias how communities approach new problems and identifying previous experiences helps to identify what aspects of history will influence the future.

Prioritizing Informed Consent helps with many steps in the process of integration

Informed consent is an area where there are some of the starkest differences between Charlottesville's introduction and San Francisco's. While it is unfeasible to get the level of informed consent as a traditional science experiment, as Downey notes in the engineering as social experimentation framework (Downey, 2005) that does not mean that all efforts are futile in aiming to achieve informed consent to the greatest extent. Informing all community members can be logistically challenging, but absolutely crucial in accurately gauging response to something new like e-scooters. Where San Francisco had scooters appear without city council meetings and public input, Charlottesville city took much greater care in gathering public input,

which in turn generated more positive press coverage of the developments and less negative push back from residents. Charlottesville is an example of how effort at the beginning of the process carries through and in turn makes it more efficient to gather informed consent during the rest of the process.

A key facet of gathering informed consent often left out is that of perceived and communicated risk. Scooters can be dangerous to riders, pedestrians, and cars whether in motion or parked on a sidewalk. Residents, council leaders, and administrative agencies need to have clear communications on past and present cases of injuries due to e-scooters, and on what actions residents can take if they are injured as a result of them. That clear communication may also help to narrow the divide between some riders who may not be aware of the risks and consequences and those who choose not to ride due to the risks and unify more people to opt for safer devices and procedures in how they're operated. When more residents are in agreeance there can be more productive legislative action going forward, helping e-scooters and potential future micromobility devices integrate into transportation landscapes.

Perceived Negligence vs. Malice

Although analyzing a negative event with hopes of determining if it was due to negligence or malice can conclude without distinctive results, there can be differing public responses to the two perceived causes of those negative events. In San Francisco, it is unlikely that scooter companies like Bird, Lime, and Skip held malicious intents in introducing their scooters without prior approval, as that would hurt their business success in both the short and long term. However, public sentiment of those affected by misplaced scooters posing hazards

echoed deeply disapproving opinions of motives of those companies, as represented by Supervisor Aaron Peskin's comment: "They've kind of behaved like a bunch of spoiled brats." (Utehs, 2018) Sentiments such as Peskin's demonstrate the standard to which tech companies are held in public spheres, especially when their products affect so many people. That perception of malice and arrogance likely played a role in city officials deciding to place a ban on scooters altogether soon after Peskin's comment.

There does seem to be more lenience given when there is evidence of good intention, even with cases of entities like city governments or scooter companies overlooking potential negative aspects. Mesthene's research claims that stakeholders must evaluate the goals of society when disruptive changes are on the horizon. (Mesthene, 1970) Failing to do so would likely exhibit as negligence versus malice, although the consequences might appear similar to those in the community whose streets and sidewalks are now shared with scooters. Charlottesville's requirements during the pilot programs for strategies to promote equal access to the new micromobility is a great example of stakeholders incorporating societal concerns into their decision-making and planning. While negligence and malice may be lumped together in discussions about negative consequences of new technology, there are strategies such as forward-thinking about equity shown effective in Charlottesville that can smooth over understandings and sentiments when things go wrong, as (Martin & Schinzinger, 2010) says they're bound to.

Communications are crucial

The ongoing communications between residents and city council are crucial to the success of e-scooters, and the tone of those communications indicates either adherence and respect of informed consent, or the ignorance of it and subsequent conflict. San Francisco's District attorney issued cease and desist letters to scooter companies including Bird, which had refused to remove the scooters when asked previously. The non-compliance on part of the scooter companies only exasperated the sentiments of city officials, whose proceeding communications reflected the negative reactions.

A key component of the communications between stakeholders is about delegating responsibility. In a science experiment, there are explicit tasks for which individual scientists or groups of scientists may be responsible. While the clear time, location, and goals serve as bounds of experiments' possible effects, engineers can still take some lessons from the ideal experiment scenario and past interactions with real world applications in order to guide their projects to successfully integrate into the communities they hope to reach. The most salient lesson is the importance of clear communications about what entities are responsible for what effects of new technologies. The clearest example of a misstep regarding this principle is the city authorities, residents, and scooter companies scrambling to cope when customers would operate the scooters against the terms and conditions, riding in the sidewalks or other hazardous places, parking in ways that inhibit mobility for pedestrians, or posing a danger to other bikes or cars in the road. Because there was not clear agreement from the beginning introductions of scooters in San Francisco, residents and community leaders felt they could not tolerate the negative consequences of the scooters. On the flipside, when Charlottesville and San Francisco both included requirements for distribution and locations of scooters for companies participating in

their respective pilot programs, they saw improvements to measures of equitable access across demographics in their communities. When responsibilities for each stakeholder are clear, there is more chance for success of new technologies, and less room for the negative consequences to go without remedy.

Conclusion

As concerns mount surrounding the changes of population distributions, particularly the growth of cities, engineers and policymakers alike seek solutions to problems such as increasing greenhouse emissions, traffic congestion, and equitable access to transportation. While only the future will tell if micromobility developments such as shared-dockless e-scooters can serve as viable alternatives to polluting and congesting automobiles or limited span public transit, evaluating what goes well and what can be improved in various cities helps us to approach new modes of mobility beyond scooters. While the responsibility of inventing, perfecting, and integrating new modes of mobility fall on no one individual resident, city council, company, or government, the success of new technologies like e-scooters depends on the communication between stakeholders, delegation of responsibility, and proactive approach to incorporating them while mitigating the negative effects.

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