2 The Livable City: The Limits and Dangers of New Technology

In 2014, the first time Steve Buckley saw a picture of Google's self-driving car, he nervously considered the future.[1]

Throughout his life, Buckley had been "infatuated with how easy it was to move about the country." By the time he was thirteen years old, he had already visited forty-nine states. Buckley followed his passion for travel to a career in transportation services—first designing highways in Pennsylvania and Maryland, then serving as deputy commissioner for transportation in Philadelphia, and now holding the position of general manager of transportation services for the City of Toronto. And although Buckley had followed the development of autonomous vehicles (AVs) over those years, he "was always skeptical of it." He thought the technical challenges were "insurmountable."

But when Buckley saw that photo of Google's self-driving car, he realized that AVs were headed for Toronto—and every other city—and that they would transform urban life. "Pretty quickly it became apparent that this was more than just a transportation issue," Buckley says. "What if Google comes in at night and dumps 10,000 of these on our streets? What would we do?"

Buckley was no stranger to the disruptive potential of new transportation technology. In 2014, he was assessing how to respond to the on-demand transportation service Uber, which had recently begun operating in Toronto in defiance of local regulations. Like most cities, Toronto had not developed any plans to assess, manage, or regulate Uber. And given the novel ways that Uber utilized technology to provide transportation, the city was not sure what regulations it could, and should, enforce. So as Uber rapidly expanded its operations, Toronto was struggling to catch up.

Ryan Lanyon, Buckley's colleague in Toronto Transportation Services, saw the revolution presented by Uber and realized that "automated vehicles could be a disruptive force at a much broader scale." When AVs are deployed, says Lanyon, "we can't have the same reaction. We really need to get ahead of this."[2]

Buckley and Lanyon formed an Automated Vehicles Working Group in 2016 to educate division heads and city staff about the potential impacts of AVs. They began with a seemingly simple question—What will vehicle automation mean for Toronto?—and found abundant optimism that AVs hold almost endless promise to improve cities.

First off, vehicle automation could dramatically increase motor vehicle safety. In 2015, almost 2.5 million people were injured and over 35,000 people died in motor vehicle crashes in the United States. Human error is responsible for 94 percent of automobile accidents: in 2015, almost a third of all traffic fatalities were related to drunk driving; another 10 percent of fatalities were due to distracted driving.[3] Self-driving cars—which cannot get drunk, distracted, or tired—promise to eliminate the grim dangers of driving. An analysis from the Eno Center for Transportation found that if 90 percent of cars in the United States were autonomous, there would be 4.2 million fewer crashes per year and 21,700 fewer traffic fatalities—equivalent to saving 60 lives every single day.[4]

Self-driving cars could also rapidly increase the speed of travel. With improved perception, connectivity, and reactivity in comparison with human drivers, AVs may be able to travel at high speeds without the need for large headways. The Eno Center estimated that at 90 percent AV penetration, roadway capacity would double and congestion would fall by up to 60 percent.[5] The chief technology officer of a major automotive parts manufacturer has proclaimed that "if every car was talking to each other, traffic flow would be incredibly smooth: no traffic jams."[6] So drastically will AVs relieve congestion that the urban designer Kinder Baumgardner has named them "clairvoyant vehicles."[7]

AVs' increased perception and their heightened ability to communicate with urban infrastructure might even enable cities to remove that indelible signifier of urban traffic: red lights. "Imagine a city without traffic lights, where lanes of cars merge harmoniously from one to the next, allowing traffic to flow smoothly across intersections. This futuristic vision is becoming reality," proclaims the Senseable City Lab at MIT.[8] By replacing traditional

intersections—"natural bottlenecks"—with intelligent intersections that act as "orchestra conductors" for a city's vehicles, the MIT researchers suggest, cities could double street capacity and significantly reduce traffic delays.[9]

AVs could also enable transformations in urban design. "As speeds increase, fewer lanes are needed and more freeway lanes will be decommissioned," predicts Baumgardner.[10] There is even more excitement about AVs drastically reducing the need for parking in cities. As cars begin to drive themselves, it may no longer be necessary to leave cars sitting at downtown curbs or parking lots all day. Instead, a self-driving car could drop off a passenger in front of her office and then zoom away to pick up another passenger or park itself in an out-of-the-way location. According to the manager of Audi's Urban Futures Initiatives, "Parking will be moved indoors and outside of city centers, freeing up outdoor lots and spaces for development and public space."[11]

AVs will provide further benefits by relieving people of the burden of driving, promising mobility for broad swaths of the population who currently lack access to transportation or the ability to drive. A driver's license may no longer be a mobility barrier for the elderly, the disabled, and children. For example, a 2017 report concluded that autonomous vehicles could help 2 million people with disabilities access jobs and 4.3 million access medical appointments.[12] Moreover, because people will no longer be responsible for driving, time spent in a car may be reclaimed for other purposes. Morning commutes could become opportunities to catch up on email, read the news, or watch TV.

Given all of these expected benefits, there is remarkable optimism about how autonomous vehicles will improve cities. In 2013, Morgan Stanley reported that a world of ubiquitous AVs is possible by 2030 and will be a "utopian society."[13]

This may sound amazing, but we have heard such promises before. The Motor Age envisioned in the 1930s was to be "an automotive millennium without accidents, congestion, or delays."[14] The 1939 World's Fair in New York City highlighted a General Motors–sponsored "wonderland" called Futurama, which prophesied a "modern traffic system" with "greater efficiency" that would enable the "elimination of congestion" and "better ways of living."[15]

When it comes to urban transportation, we have been waiting for a century for new technology to provide a solution. And just as last century's

cities were re-created in the image of Futurama, leading to congested highways and meager pedestrian and public transit facilities, so today's cities may become landscapes that serve, above all else, the optimized flow of self-driving cars.

As they considered the potential impacts of AVs in Toronto, Buckley and Lanyon grappled with a seemingly endless tangle of questions and scenarios. Indeed, every city faces the daunting task of determining how it will be affected by the cars of future. But the most important task for a city is not to predict the future of technology and hope for the best—it is to shape its own future through thoughtful use of technology.

* * *

To avoid repeating history—to avoid falling into the Futurama trap—we must learn from the past. The process by which the Motor Age came to be desired and pursued demonstrates the dangers of putting too much faith in technology to solve social problems and highlights the critical decisions we must make today about how to prepare for self-driving cars.

At the start of the twentieth century, it was commonly accepted that streets were public spaces where streetcars could run, people could walk, and children could play. When cars were introduced in large numbers onto the streets of American cities in the 1920s, they brought chaos and conflict. Gruesome accidents horrified the public. Parents feared for the safety of their children. Downtown business owners worried that congestion would diminish profits. Early attempts by police officers to create order in the streets proved fruitless. There seemed to be no way for cars to peacefully coexist with pedestrians, children, and streetcars.

The car was an "intruder" in the existing balance of city streets, writes the historian Peter Norton in *Fighting Traffic*. As a new technology "incompatible with old street uses," Norton explains, cars "violated prevailing notions of what a street is for."[16] The resulting destabilization instituted a period of "interpretive flexibility," during which social conceptions of cars and streets were in flux.[17] Motorists, families, police, businessmen, and automotive manufacturers all jockeyed to define how cars should be used and who had a rightful claim to the street.

In need of a neutral way to mediate between these parties, cities turned to engineers for a solution. Despite the contentious nature of managing urban streets, traffic engineers were trusted as "disinterested experts" to solve the problem.[18] Because they "made [deductions] in a scientific manner,"[19]

it was commonly believed that engineers could devise an objective and socially optimal solution.

Over the previous several decades, engineers had displayed technical expertise in helping cities efficiently manage overburdened public utilities such as water and electricity. There was no reason to think that traffic was any different. To engineers, writes Norton, "City streets were . . . like water supply, sewers, or gas lines: a public service to be regulated by experts in the public interest."[20] Engineers derived new methods (such as the traffic survey) from their work managing these other utilities. Likening the flow of traffic to the flow of water or sewage,[21] they were confident that "scientific organization of traffic . . . could cut traffic congestion at once by half."[22]

Here we see our first instance of tech goggles, a prelude of what is to come: in keeping with their past work on other public utilities, traffic engineers "stood for the logic that efficiency worked for the benefit of all," writes Norton. "They saw their mission as optimizing traffic capacity."[23] And so engineers began altering traffic signal timings based on equations developed to maximize how many cars each street could carry.

Improving traffic flow came at a cost, however, for optimizing one aspect of urban life requires restricting others that would impede that efficiency. Motorists may have benefited from the updated signal timings that enabled the faster flow of cars, but pedestrians discovered that these changes had made streets inhospitable. Navigating city streets became, in the words of a 1926 *Chicago Tribune* report, a "succession of heart thrills, dodges, and jumps."[24]

By focusing on vehicle speeds and ignoring the needs and behaviors of pedestrians—who were left out of the equations entirely—traffic engineers increased traffic flow but, in the process, Norton explains, "helped to redefine streets as motor thoroughfares where pedestrians did not belong." In turn, streets became "socially reconstructed as places where motorists unquestionably belonged."[25] Through a process known as "closure," the interpretive flexibility about streets created by the introduction of cars yielded to a social consensus that streets were for vehicles and that pedestrians who got in the way were troublesome "jaywalkers."

This shift in social conceptions prepared the way for the auto industry to promote self-serving arguments that cities should be redesigned to prioritize and facilitate the passage of cars. Congestion was blamed not on the spatial inefficiency of cars but on insufficient street space. Similarly, the dangers of cars were framed as failures of pedestrians and antiquated

streets. Through advertising campaigns and scale models such as Futurama, automobile manufacturers, oil companies, and others with a financial stake in the growth of cars and highways generated popular support for a utopian Motor Age in which cities would be remade for cars.[26] These groups leveraged their newfound muscle into massive government investments, most

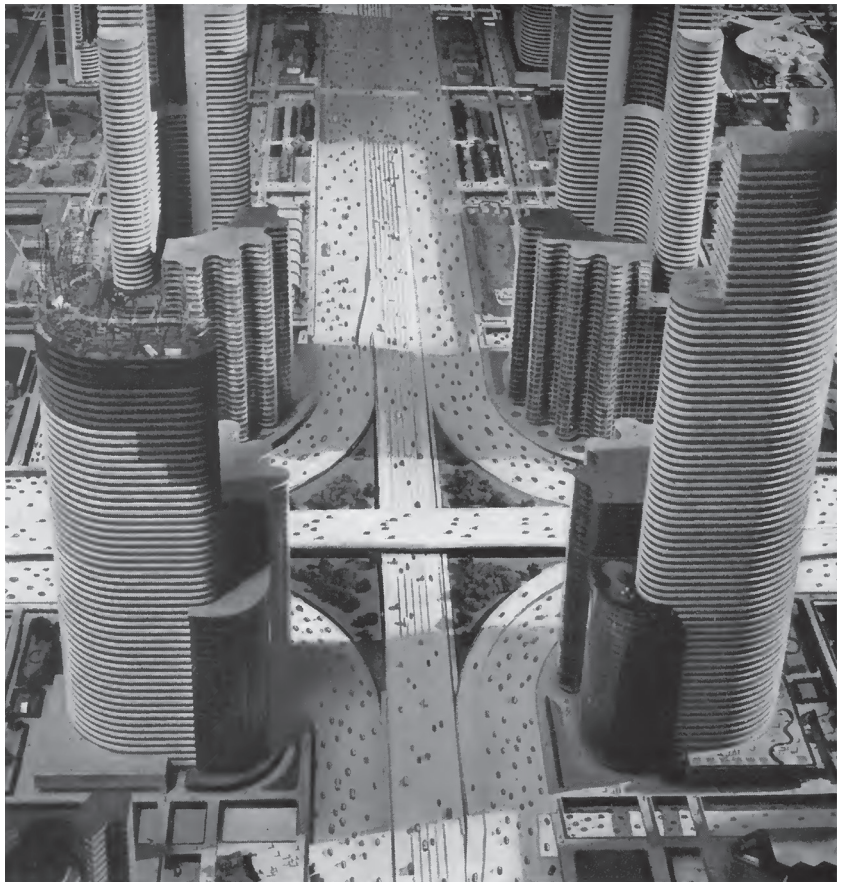

Figure 2.1
The Futurama exhibit created by Norman Bel Geddes for the 1939 World's Fair in New York City. Futurama, which was sponsored by General Motors, portrayed a vision for the city of 1960, where automobile collisions and traffic congestion would be eliminated.
Source: Norman Bel Geddes, *Magic Motorways* (New York: Random House, 1940), p. 240. Copyright © The Edith Lutyens and Norman Bel Geddes Foundation, Inc.

notably the Interstate Highway System: authorized in 1956, it represented the largest domestic public works program ever undertaken at that point in world history.[27] It is only in the past several decades, through a renewed focus on designing cities for people rather than cars, that many of these automobile-focused designs have been reversed.

Embedded in the focus on efficient car travel are two critical flaws, both of which rear their head today as we begin planning for self-driving cars. The first issue with traffic models, as just described, lies in what they choose to measure and ignore. While engineers go to great lengths to evaluate automobile flow, they pay far less attention to the throughput and safety of pedestrians and cyclists, as well as to public transit. "When a traffic engineer says they've optimized a traffic signal, that typically means they made it the best for the motorists," explains one transportation engineer.[28] Another notes, "*Synchro*, the standard software [that traffic engineers] use, is based on minimizing auto delay and it doesn't even calculate pedestrian delay."[29]

Because most traffic engineers strive for efficiency—defined solely in terms of automobile travel—they do not measure whether roads meet the needs of pedestrians and transit riders. And what is left out of equations tends to be not just ignored but devalued. Stripping away pedestrian facilities eases traffic, while the costs to pedestrians, cyclists, and others are not apparent in the models; such action therefore appears, quantitatively and scientifically, to be an unequivocal boon for society. In turn, engineers devise solutions for urban congestion without considering their full impacts on people and communities.

Although an explicit plan to turn streets over to cars would have been met with strong resistance, the use of mathematical models to improve the efficiency of urban streets masked this radical transformation under a veneer of objectivity. There was little recognition that increasing traffic efficiency could benefit certain groups at the expense of others.

The second major flaw with traffic models can be best elucidated with another history lesson. In 1936, New York City opened the Grand Central, Interborough, and Laurelton parkways to great fanfare. After years of heavy traffic congestion throughout New York, these ambitious new projects dreamed up by the "master builder" Robert Moses promised to solve the region's traffic woes "for generations." But instead of generations, traffic relief lasted just three weeks, reports Robert Caro in *The Power Broker*, his

epic biography of Moses.[30] Undeterred, Moses continued to build. The Triborough Bridge opened in 1936; the Wantagh State Parkway Extension, in 1938; and the Bronx-Whitestone Bridge, in 1939. Every time, traffic relief was promised. Every time, congestion remained severe.

Planners began to notice a perplexing pattern: "every time a new parkway was built, it quickly became jammed with traffic, but the load on the old parkways was not significantly relieved."[31] Cars seemed to appear out of nowhere. Congestion was so bad following the opening of the Triborough Bridge that the *Herald Tribune* exaggeratedly described observing a "cross-country traffic jam." As the newspaper put it, "motoring residents of the Bronx . . . decided at the same moment to head for the ocean by way of the new bridge and the Grand Central Parkway. And nearly all of them got stuck—as did countless other motorists."[32] In ways that New York's planners and engineers "did not even pretend to understand," recounts Caro, "the construction of this bridge, the most gigantic and modern traffic-sorting and conveying machine in the world, had . . . failed to cure the traffic problem it was supposed to solve."[33]

Moses's New York may represent an extreme example—as so many people were eager to travel that new roads filled almost instantly—but it is indicative of a common phenomenon known as "induced demand." The economist Anthony Downs first defined induced demand in 1962, when he determined that on "urban commuter expressways, peak-hour traffic congestion rises to meet maximum capacity."[34] Downs pointed to several factors in explaining why, "if a road is part of a larger transportation network within a region, peak-hour congestion cannot be eliminated for long on a congested road by expanding that road's capacity."[35] The most obvious reason is that drivers who previously had taken other routes start traveling on the expanded, faster road (Downs calls this "spatial convergence"). Meanwhile, drivers who formerly scheduled their travel to avoid congested periods take advantage of the increased road capacity and start driving during peak hours ("time convergence"). Others stop taking public transportation and start driving ("modal convergence").[36] Additional causes of induced demand include people making discretionary trips they would have forgone in the face of too much congestion and the increased travel needs that sprawling development (facilitated by increased road capacity) creates.

Recent analyses have corroborated Downs's observations. In a 2011 study of urban traffic patterns between 1983 and 2003, the economists Gilles

Duranton and Matthew Turner determined that increasing road capacity generated proportional increases in driving. They conclude, "Our results strongly support the hypothesis that roads cause traffic."[37]

Drawing on their work with public utilities, last century's traffic engineers had mistakenly assumed that cities contain a relatively fixed quantity of transportation needs, so that increasing road capacity would enable everyone to reach their destinations more quickly. But in fact, the primary circumstance keeping many people off the road is congestion. Increasing roadway capacity invites more people to take trips that they would have forgone to avoid traffic. Because engineers overlooked how new or expanded roads would change behavior, they failed to incorporate this second-order effect into their mathematical models and thus drastically overestimated the benefits of increasing roadway capacity. More people might be able to get around and at faster speeds, but congestion is far from eliminated.

* * *

Technology enthusiasts are repeating mistakes made in the past when they diagnose self-driving cars as the route to a "utopian society." They ignore the multiplicity of needs in cities and the complexities of traffic, instead devising narrow solutions that revolve around technology. In fact, the utopian society that features ubiquitous self-driving cars is incoherent and undesirable.

Any realistic prognostications for AVs and traffic must begin with induced demand. By increasing travel speeds and the density of vehicles on the road, introducing autonomous vehicles to city streets is largely equivalent to expanding the physical capacity of those streets. And given that travel demand rises when roadway capacity increases, people will take advantage of these benefits by driving more. This induced driving will add congestion, especially during peak commuting hours, largely negating the benefits that faster travel might provide.

The phenomenon of induced demand also suggests that autonomous vehicles will generate even more sprawling urban development than is already typical in the United States. Counterintuitively, although average travel speeds have risen notably over the past century, average travel times have remained remarkably consistent, because travel distances have also increased: research has shown that people take advantage of increased travel speeds not by enjoying shorter commutes but by moving further

away from the urban core.[38] We should thus expect that to the extent AVs enable faster travel, they will lead to increasingly spread-out communities rather than shortened commutes.

Moreover, if time that was previously spent driving is reclaimed for work or leisure, people may be willing to accept even longer travel times, further increasing the distances traveled. Such AV-enabled sprawl could lead to disinvestment in downtowns while also having devastating consequences for the environment: the further away people live, the more they drive and the more greenhouse gases their vehicles emit.

Similar logic explains the challenges of reclaiming parking infrastructure for pedestrian plazas, bike lanes, and apartment buildings. After dropping off passengers, self-driving cars could drive themselves to pick up other passengers or park in peripheral locations, unlocking valuable downtown real estate for alternative purposes. But just because the cars are empty does not mean they are not on the road. If parking lots are developed outside of city centers, self-driving cars will need to get to and from those facilities. If self-driving cars take frequent zero-occupancy trips in and out of the urban core, the number of vehicles on the road could increase dramatically. Instead of being congested with people circling around to find parking, cities may become congested with empty cars driving in and out of downtown. Alternatively, if congestion is too severe, many people may consider it cheaper or more convenient to leave cars in traditional downtown parking facilities. This choice would severely hinder efforts to refashion existing parking infrastructure for more productive uses.

Most importantly, dreams of autonomous vehicles also repeat the mistake of prioritizing traffic efficiency over walkability and community vitality. Consider the claim that travel times will be severely reduced by increased travel speeds and the elimination of red lights. Sounds fantastic—if you're in a car. What kind of city would this create for everyone else? The MIT simulations that demonstrate cities without traffic lights show cars traveling seamlessly through an intersection with remarkable efficiency when compared with their movement on traditional streets.[39] But there's one important element missing: people. The simulations do not include a single person walking, cycling, or riding a bus. Yet the intersection shown is among the most walkable locations in the entire United States[40] and is crossed by some of Boston's busiest pedestrian and transit corridors. If even

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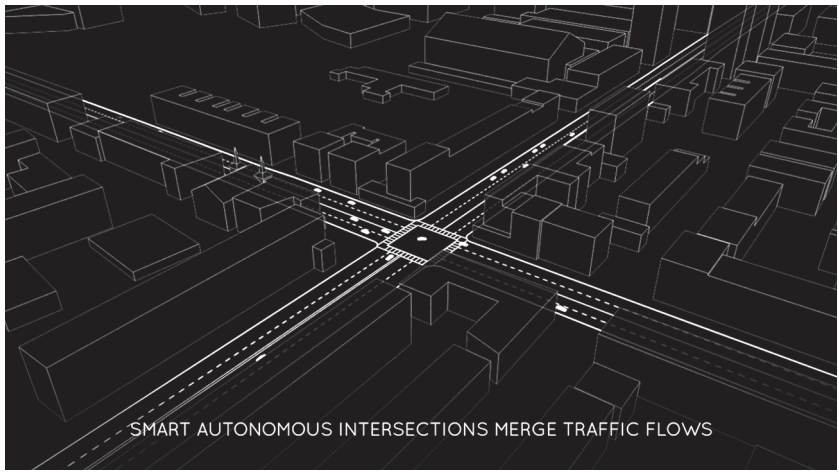

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Figure 2.2

(a) A screenshot from the MIT Senseable City Lab's demonstration video of a city without traffic lights, depicting autonomous vehicles zooming through an intersection in downtown Boston without needing to slow down.

(b) A photograph, taken on a typical Saturday afternoon, of the same intersection, where cars shared the street with pedestrians, cyclists, and buses.

Sources: (a) Senseable City Lab, "DriveWAVE by MIT SENSEable City Lab" (2015). http://senseable.mit.edu/wave/. (b) Photograph by Ben Green. Boston, Massachusetts. April 2018.

this location has been turned into a high-speed interchange, it is difficult to fathom where everyone in those cars is in such a rush to go.

If we want cities in which people are able to cross the street—a reasonable desire, one would think—then we must avoid visions of downtown intersections where AVs speed through without ever stopping. Even if we permit occasional red lights to allow people to cross the street, allowing high speeds on city streets would severely diminish safety, walkability, and vitality. Main Streets would turn into high-speed corridors: imagine how unpleasant it would be to eat lunch or go shopping along the side of the freeway. Although the prospect of unencumbered AV travel is exciting to many technologists, it is not a central feature of successful urbanism. A city devoid of traffic lights in the interest of enabling high-speed streets would also be devoid of people and character.

In conceiving of traffic as an optimization problem that requires a technical solution, proposals for AV-filled smart cities remove all normative concerns from consideration and position traffic efficiency as a neutral and socially optimal objective for cities. Although enabling cars to travel more efficiently is valuable, it is not the only priority for cities. More importantly, efficiency involves political calculations: What should be made efficient? Who gets to decide? By what means should efficiency be attained?

The answers to these questions can have enormous social and political consequences. What society chooses to measure and optimize is an embodiment of our priorities. So long as we value smooth car traffic over livable streets and public transit, efforts to enhance transportation will actually be aimed at easing congestion. Just as last century's efforts to make streets more efficient for cars prompted radical urban designs that benefited automobiles over pedestrians and streetcars, modern attempts to facilitate efficient travel for self-driving cars could prompt urban designs that benefit AVs (and their passengers) at the expense of pedestrians, transit, and public space. At the very moment that cities are undoing the damage created by last century's misguided dreams, we appear ready to revert back to our bad habits.

Framing traffic as a technical challenge also provides cover for private companies to promote their corporate agenda under the supposedly neutral premise of improving efficiency, much as the auto industry did with cars and highways last century. These days, Ford is promising that self-driving cars will create "a future where traffic congestion is drastically reduced."[41] Lyft has taken this argument even further, claiming that "end[ing] traffic

[is] really simple."[42] Its co-founder John Zimmer has said that with AVs and technology that encourages people to carpool, "for the first time in human history, we have the tools to create a perfectly efficient transportation network."[43]

Not only do such proposals falsely present intractable mobility and congestion challenges as easy to solve with new technology, they also blind us to how other approaches—in this case, alternative transportation modes and urban planning policies—can more effectively address these problems. Instead, these corporate pitches focus on how to make driving in cars more efficient, inevitably suggesting that their product or service is the solution. And because these scenarios are presented as optimizing traffic efficiency, they can be framed as advancing universally desired outcomes rather than profits. In response to this rhetoric, some cities and states have considered reducing investments in public transit, expecting that self-driving cars will make such systems obsolete,[44] and begun rolling out the red carpet for AV companies. No state has reduced AV regulations more aggressively than Arizona, leading several companies to flock to Phoenix[45]—and leading also to the first recorded pedestrian fatality from a self-driving car, in Tempe in March 2018.[46]

These limits and caveats do not entirely negate the benefits of autonomous vehicles, but they highlight where dreams involving supposedly beneficial technologies can go wrong, underscoring the gravity of decisions that cities must make in the coming years. Self-driving cars will almost surely enhance safety and mobility, and in some cases might even enable parking facilities to be reimagined for new purposes. There is much to look forward to. But AVs will not create utopias—and the best way to avoid creating dystopian futures is to recognize the limits of self-driving cars and the barriers to their successful implementation.

It is easy to imagine how developing our expectations of AVs under the influence of tech goggles could lead, through the tech goggles cycle, to cities that are optimized for self-driving cars but unwelcoming to pedestrians, transit, and vibrant public space. First, as we have seen, tech goggles cause many to perceive improving urban mobility solely in terms of making traffic more efficient—getting every car from its origin to its destination as quickly as possible. These beliefs lead technologists and cities to prioritize AVs as the solution to almost every transportation issue. As cities are designed to facilitate self-driving cars and, in turn, alternative transportation modes are

neglected, people will have little choice but to rely on AVs for mobility, and we may become even more blind to other priorities and potential solutions.

These dangers animate the distaste of the urban planner and *Walkable City* author Jeff Speck for attempts to optimize traffic flow. "What upsets me most about traffic studies is the hegemonic dominance that they hold in the municipal discourse," he explains. "Somewhere along the line, we decided as a society that the only inviolable principle in the design of our communities was that we had to fight traffic congestion. Shouldn't the questions be, Will it increase vitality? Will it increase equity? Will it increase the success of our city?"[47] In this light, Speck believes that "autonomous vehicles are the right answer to the wrong question."[48]

* * *

With an inquisitive yet principled approach to automated vehicles, Toronto is demonstrating how a Smart Enough City can consider the right questions and priorities when preparing for the changes promised by revolutionary new technologies.

Reflecting on the potential and limits of self-driving cars, Steve Buckley realized that Toronto needed to actively pursue the future it desired rather than passively allow technology to dictate the city's future and hope for the best. "Why are we just letting it happen to us?" Buckley asked himself. He shifted the conversations of the Automated Vehicles Working Group away from their initial focus—"What will vehicle automation mean for Toronto?"—and toward a different question: "How do we plan for AVs and how do we shape it?" Because, as Buckley explains it, "We can't let the technological tail wag the city dog."

After all, as Ryan Lanyon observes, self-driving cars come with opportunities but are no silver bullet. "We know from past experience that any efficiencies gained can induce additional demand," he says. "Whether vehicles are automated or manually driven, there's still a limit to the number that can be accommodated in our existing road space. Mass transit is still the best and most efficient way for our municipality to move large quantities of people in certain areas and certain corridors."

Buckley and Lanyon began considering how Toronto could prepare for and shape the forms that self-driving cars take. The key questions, according to Buckley, are, "What are the positive aspects of these systems, and

what are the potential negatives or downsides? How do you structure these systems in a way that permits you to get as many positives out of them as you can, and to future-proof yourself against problems?"

Toronto, Lanyon adds, "has a vision for what it wants to become. It wants to be more equitable. It wants to be more sustainable. It wants to continue to develop economically." Lanyon points to Toronto's efforts over the past decade to invest in transit and walkability, rather than developing new facilities or increasing capacity for automobiles. He explains, "We want to reduce congestion. We want to encourage people to use public transit and active transportation. We want to make it a more livable city. We want our streets to be more attractive. Whether we have vehicle automation or manually driven vehicles, we have the same objectives." To Lanyon, the essential question is not how Toronto can optimize itself for AVs, but rather, "How do we harness disruption and paradigm shift to get us toward the goals that are already established?"

To answer this question, Lanyon and Buckley began leading the Automated Vehicles Working Group through assessments of how AVs could advance Toronto's priorities. They analyzed the benefits and drawbacks of the potential ownership models for self-driving cars: private ownership (much as cars are owned today) and shared, on-demand use (like Uber). While both scenarios provided safety benefits, Buckley explains that "a shared model would be better than having a continuation of private ownership of automated vehicles." On-demand AVs are more likely to reduce the need for downtown parking, shrink the number of cars on the road, and expand mobility for many who cannot afford to own a car. Private ownership, on the other hand, might enhance roadway capacity but would also generate longer trips, lead to more unoccupied vehicles on the street, and contribute to increased sprawl.[49]

The Working Group also began planning for a future with AVs with more of an eye to infrastructure, so that no matter how self-driving cars come to be owned, Toronto can take advantage of the technology's benefits. To make roads safer for AVs, the city is assessing the need for improved pavement markings and is researching traffic lights that wirelessly broadcast their signal rather than require cars to have a direct line of sight. And to aid in reclaiming parking space for new purposes if the opportunity arises, the city is reviewing its parking infrastructure and regulations.

Meanwhile, the AV Working Group continues to facilitate discussions and educate public officials through scenario-planning exercises. It plans to launch a pilot in 2020 using self-driving shuttles to improve accessibility to and from transit stations.[50]

In following this approach, Toronto is transcending the false dichotomy between the smart city and dumb city: rather than unreservedly embracing AVs or rejecting them entirely, the city is sticking to its planning and transportation goals while exploring the opportunities offered by technology to achieve them. In this way, it avoids the smart city trap of embracing technology without considering how to create more livable urban environments. For although an automobile-dominated city with AVs is likely preferable to an automobile-dominated city without AVs, both pale in comparison to a livable city where public transit, walkability, and public space can thrive.

"We have an opportunity to start talking about it and getting it right," Buckley says. "It's better to do that now than to let the genie out of the bottle and try to put it back in."

* * *

Some cities are going even further than Toronto, moving beyond planning exercises by taking bold steps to improve mobility and livability through technology. Leading the way is Columbus, Ohio, winner of the Smart City Challenge that the U.S. Department of Transportation (DOT) launched in December 2015. The challenge was designed to spur mid-sized U.S. cities to plan for a "first-of-its-kind smart transportation system" and came with a $40 million prize[51]—money that one city could use to revolutionize its transportation ecosystem.

Growing up in Columbus, Jordan Davis always had a chip on her shoulder. "Columbus can never stand alone without the 'comma Ohio,'" she laments. "Nobody knows us." A graduate of Ohio State University and the proud daughter of a chamber of commerce president, Davis says that "it's in my DNA to want to build a better city." Given Columbus's recent economic renaissance and downtown revival, not to mention its status as the Midwest's fastest-growing city, Davis has long been eager to bring more attention to everything her hometown has to offer.[52]

When the Smart Cities Challenge was announced, several local organizations joined forces under a new umbrella organization called Smart Columbus, gathering in a joint working space in a local startup incubator

to develop a proposal. These efforts were rewarded in June 2016, when the DOT announced that Columbus had beaten seventy-seven other cities (and a group of seven finalists that included Austin, Denver, and San Francisco) to win the challenge. What stood out about Columbus's efforts was not a futuristic plan to end traffic with a fleet of AVs but its focus on addressing transportation hurdles that diminish social welfare.

"This is exactly what Columbus needs," says Davis, who directs Smart City Strategy at the Columbus Partnership, a nonprofit civic organization that emphasizes local economic development. "Transportation has not always been our shining star. I think this is our moment to think differently about what our future can look like."

That Columbus beat numerous other cities, including several viewed as hotbeds of the country's transportation and technology sectors, was no fluke. "It's not like we were sitting here waiting for something like this to happen," explains Thea Walsh, director of transportation for the Mid-Ohio Regional Planning Commission (MORPC), which played an integral role in articulating the city's vision for the challenge. "We had been doing a lot of planning locally, and when that opportunity came out, we realized, 'Wait a second, that kind of sounds like the things we're talking about and planning for.'"[53]

Columbus had spent the previous years identifying and addressing gaps in its transportation system and had begun exploring the opportunities that new technology could provide. "We enjoyed wonderful sprawl in central Ohio from 1880 to 2010," MORPC's planning director Kerstin Carr sarcastically explains. "There is a huge reliance on single-occupancy vehicles," adds her colleague Walsh. "We're not a community that has high-capacity or high-quality transit systems whatsoever. This is very much a bigger city operating like a cow town when it comes to transportation." Given its projection that the region will grow by 500,000 people and 300,000 jobs by 2050 (from a 2010 population of 1.8 million),[54] the city recognized that it needed a new approach.

In 2013, MORPC conducted a long-term planning assessment called insight2050. It considered four potential growth scenarios that the region could pursue over the next several decades, ranging from sprawling development that followed past trends to dense development that maximized infill and redevelopment. Each scenario was evaluated on outcomes related to land consumption, energy use, transportation, and costs.

Across the board, the results were clear: "the more dense, the more mixed-use, the more walkable and compact our communities are getting, the better," says Carr. Compared to the future that would result if Columbus continued following its traditional planning approach, the densest scenario was projected to decrease the region's total driving by 30 percent, reduce greenhouse gas emissions by 33 percent, save the city $80 million per year, and significantly improve public health.[55]

This was "a very low-tech conversation," emphasizes Walsh, "but it needed to be had so that we can facilitate better service." Only after the groundwork of developing a planning vision for the future had been laid does Walsh believe that the city was ready to begin thinking about how technology could advance its goals, making it possible to win the Smart City Challenge.

With the DOT grant in hand, Smart Columbus is experimenting with new approaches to address the issues that insight2050 identified. One of its aims is to improve mobility around Easton, a major office and retail park northeast of downtown Columbus. "It's not accessible," notes Carr. Getting to Easton from the nearest transit stop requires crossing ten lanes of traffic and then walking a while further. Moreover, Easton itself is sprawling and difficult to navigate, forcing people to drive between sections or else remain in isolated pockets. To improve transit accessibility and mobility within the complex, Smart Columbus plans to deploy self-driving shuttles. One will connect the transit center to Easton; another will travel within the complex. Hopefully, says Davis, this solution will help create "an independent mobility experience if you don't have a car."

Beyond improving mobility and transit generally, Columbus's efforts embody a vision to mitigate inequality and improve social welfare. "You have to democratize mobility," explains Carla Bailo, a former Nissan executive who runs mobility research at Ohio State University and who played an integral role in rallying the community to apply for the Smart City Challenge.[56]

Smart Columbus's efforts to address inequality through transportation are focused on Linden, a neighborhood situated between downtown Columbus and Easton that suffers from three times the unemployment rate and has less than half the median income of Columbus as a whole.[57] A critical issue in Linden is a lack of access to prenatal and early childhood healthcare, leading to an infant mortality rate that is more than twice the city average.[58] Because few who live there can afford a car and the city

provides only meager public transportation options, Linden residents often miss or are late to doctor's appointments. At one community forum, half of the residents agreed with the statements "I don't take the bus because it takes too long to get to my destination" and "It is too far to walk from home to where I want to go." According to one resident who spoke at the meeting, "there just isn't enough time to do everything in a day and get to where you need to go."[59]

Hearing these issues, most technologists would instinctively prescribe autonomous vehicles as the panacea. Indeed, Bailo reports that Smart Columbus first approached this problem "focused solely on first-mile and last-mile solutions," referring to the challenge of getting people to and from bus stops and transportation hubs. But as the group talked to Linden residents about their needs, Smart Columbus realized that Linden's barriers to jobs and healthcare went deeper than a lack of convenient transportation.

"It wasn't just about moms not getting to the doctor, but also that there was basic information missing," explains Bailo. While most Linden residents have smartphones, many lack access to a data plan or Wi-Fi. And because information about public transportation in Columbus is scattered across multiple websites and apps, even those who do have internet access struggle to determine the best way to get around. On the basis of this research, Smart Columbus is improving Wi-Fi access in Linden, especially at schools and community centers, and creating a streamlined app that unifies every transportation option. "If we ask them to surf all the different websites and create a bunch of different accounts, we're doomed to fail," says Bailo. "If we can have one simple app that provides them with their alternatives and also allows them a common payment in that app, it's doable."

An additional hurdle is that many Linden residents are locked out of transportation apps because they lack access to a bank account or credit card. Uber, Lyft, and the local car-sharing and bike-sharing companies all require a credit or debit card to pay for trips. The local bus system, on the other hand, is cash-only, which makes it difficult for social service providers to subsidize transport to doctor's appointments or work. To address these issues, Smart Columbus is creating a unified payment card and app that will make it possible for users to pay for all of the region's transportation modes. Kiosks at key locations will enable people to load cash into their accounts.

Another challenge that Linden mothers face is getting to doctor's appointments for prenatal or newborn care when they already have young

children. Getting to and waiting at a bus stop may simply not be feasible. To help remove these barriers, Smart Columbus is developing a subsidized, on-demand ride service to take pregnant Linden moms directly from their homes to medical appointments and back,[60] while also exploring how improved childcare facilities could make it more feasible for Linden residents to go to job interviews and doctor's appointments.

Columbus demonstrates two attributes key to fostering Smart Enough Cities. First, cities need to have a clear policy agenda before deploying technology. Thinking about the city's challenges and needs before thinking about technology is essential, according to Bailo. "As a city you really need to define what are our problems, how do I prioritize those, and how can technology and data make those better? Then you'll be able to make a road map for your city, based on the problems that exist and the prioritization of those," she explains. "Improving people's lives is the key element. Because otherwise you're just throwing technology and data out for the fun of it."

The second necessary ingredient is a research process that focuses on people rather than technology. As Columbus demonstrates, the best way to avoid the simplistic and solutionist mind-set fostered by tech goggles is to learn what barriers and challenges people actually face. This means getting out and talking to city residents. "What we thought was this basic problem—get people from A to B—turned into an entire support system that needs to be put in place to tackle these issues," observes Bailo. "We really needed to look at it from a more holistic viewpoint and to think about many different ways to provide transportation for the residents in this community. As geeky technology people, we wouldn't have thought about these things had we not considered the whole picture."

Despite these promising efforts, the path ahead remains difficult. Developing plans to aid an underserved community and actually serving its needs when flashier projects can be pursued remain two very different tasks. Some have worried that the focus on prenatal healthcare is waning.[61] Columbus also knows that it must learn from its past urban development mistakes: namely, a century of sprawl and the creation of disconnected neighborhoods that bred poverty. "We don't want to put ourselves in these situations again," says Walsh. "Because if we make the wrong decisions now, we'll be so tightly locked in that it will be hard to come back out of it."

The past also provides hope, however. If Columbus is successful, the city will resume its position, held long ago, as a leader in transportation

technology. In 1900, the Columbus Buggy Company (CBC) was the world's biggest buggy manufacturer, producing one-fifth of the world's supply; Columbus was the "Buggy Capital of the World."[62] The CBC also produced some of the first electric vehicles, which could travel 75 miles on a single charge. But when Henry Ford and the Model T came around in 1908, the CBC could not keep up. It went bankrupt in 1913.

Today, as part of the city's downtown revival, the old Columbus Buggy Company warehouse has been remodeled as residential lofts. For Jordan Davis, a former resident of "The Buggy," this local history is a source of constant motivation. "Think of the disruption that happened when we went from horses to cars—we were dramatically impacted by that—and how dramatic it will be when we go from humans driving to machines driving. Hopefully Columbus can win this one."

* * *

The past and future of transportation demonstrate why tech goggles are such a dangerous frame through which to pursue new technology. First, tech goggles blindly identify innovation and progress with technology. In assuming that a complex problem is easy to solve with technology, we overlook more systemic changes that may be necessary. Instead of deliberating about what type of city to create—and how AVs can support those outcomes—we consider only how to make existing cities more efficient with AVs. While automated vehicles clearly promise significant benefits (such as enhanced safety and mobility), just as motorized vehicles introduced important advances a century ago, cities are defined by more than efficient traffic flow. The preoccupation with cars (both self-driving and not) distracts us from the need for holistic urban livability as well as from other strategies to improve mobility: public transit, dense development, and congestion pricing, not to mention user-friendly apps and better childcare.

As we learned with cars, the mere fact that social norms revolve around a particular technology does not imply that the technology is optimal. This is the danger of closure, the process by which we come to a consensus about certain technologies. The historian Thomas Misa explains, "closure occurs . . . not when a neat solution emerges but when a social group perceives that the problem is solved." In fact, Misa adds, "closure may obscure alternatives and hence appear to render the particular artifact . . . as necessary or logical."[63] In this sense, we can conceive of the tech goggles cycle's

"reinforcement" stage as representing a form of closure linked to the particular technological arrangements suggested by tech goggles.

Because closure following the embrace of a suboptimal technology can blind us to better alternatives and lock us in to harmful practices, we must reject efforts to design cities for AVs. As automated vehicles begin to appear on city streets, a new period of interpretive flexibility is emerging. And given that "this flexibility tends to be greatest when an artifact is new,"[64] the decisions we make over the next several years will shape cities for decades. If we imagine cities as traffic optimization problems that only AVs can solve, we are likely to destabilize the emerging consensus that cities should foster dense, walkable neighborhoods and to instead usher in a new paradigm of designing cities to accommodate self-driving cars. The more we design society for ubiquitous cars, the harder it will be to pursue alternative visions if and when we eventually recognize their merits.

The second danger of tech goggles that emerged in this chapter is the tendency of optimization and efficiency to mask political decisions as objective, technical ones. When we misinterpret complex social issues as technology problems, we evaluate solutions along purely technical criteria and overlook their political consequences. Political debate is reduced to narrow technocratic discussions of efficiency.

This approach is blind to the full effects of making some aspect of society more efficient. Although traffic engineers were considered neutral because they employed a "scientific" approach, their models that optimized for automobile efficiency and ignored other street users had revolutionary social impacts. Similarly, today's models that optimize for AVs are presented as utopian and objective, but their disregard of social impacts beyond smoother traffic quite literally means that cities will be altered to prioritize the needs of self-driving cars over those of pedestrians and communities.

Casting social issues as technical challenges also allows companies to advance their corporate agendas without appearing partisan. Just as last century's auto industry promoted the "Motor Age" as liberating and universally desirable, so today's technology companies promote the "smart city" as a scientific way to enhance efficiency and daily life. Our recognition of the Motor Age's true proponents and the unfortunate results of its pursuit should make us skeptical about the smart city and the agenda that underlies its promises. Allowing tech companies to drive us toward the closure of

cities becoming "smart" repeats the damage of allowing the motor industry to push us toward the closure of cities embracing cars.

Smart Enough Cities must stay true to their priorities and embrace the benefits of new technology without falling prey to technological solutionism. Columbus demonstrates why it is so important to focus on real people and issues in the community rather than chase new technology. "It would be really easy for us to have a bunch of technical people in a room and deploy technologies that would be cool," says Jordan Davis. "But instead we said, 'Let's think about people.'" In doing so, Columbus discovered that the problems people faced were more complex and less closely related to technology than it expected. Technology provides some new opportunities, but Columbus knows it cannot provide all the answers. "Transportation technology is a very exaggerated space," Davis says. "I'm really excited to figure out what's real and what's not."

Making that distinction is the essential task faced by cities. To avoid repeating the mistakes of last century, we must take off our tech goggles and abandon unrealistic and utopian visions of AVs. It is only by recognizing a technology's limits and dangers that we can hope to attain its benefits.

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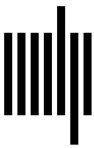

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