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Faster toward the future of mobility

There's a reason why futurists talk about the importance of high-speed data highways and their ability to facilitate the transfer of large amounts of data across interconnected networks.

It's because they know the past is also the future.

Just look at our current interstate highway system. Sure, it's crowded and congested now, but that's only because it was actually more successful than anyone ever imagined it could be. Like them or not, highways changed the world by allowing people and products to move across long distances at speeds never before possible. Highways, for all of their faults, revolutionized the world.

What's more, that revolution continues today. Maybe not physically—though more modern, smarter, and connected infrastructure is just around the corner—but online, where the increasing use of advanced data and analytics is helping to create some of the most rapid changes we've ever seen when it comes to the automobile and mobility.

Looking down the road, we believe that some of the most notable trends relate to the increased adoption of shared mobility and autonomous vehicles. In the following pages, we take a closer look at several factors helping to shape this trend, including:

- **What's next in the future of mobility**, which examines the technology and social drivers behind the adoption of smart cars and ridesharing platforms.
- **The race to autonomous driving**, which examines Americans' trust in autonomous vehicles and who they trust most to bring that technology to market.
- **Framing the future of mobility**, which studies how organizations and manufacturers can use behavioral economics to encourage consumers to more quickly adapt to changing technology.
- **The rise of mobility as a service**, which looks at how smart cars and ridesharing services can help make modern cities cleaner, more livable, and less congested.

To help put all this information in context, we also explore the broader changes in the urban landscape and how collective intelligence can help city planners conceive more efficient transportation routes. We also discuss how technology is changing the modern city in a Q&A with noted futurist and Sidewalk Labs CEO, Daniel Doctoroff.

The modern automobile—and the consumer's relationship to it—is changing. The manufacturers and industry leaders who recognize this sooner, and who adapt to these changes faster, will best position themselves to succeed in a world where mobility takes place on both physical and data-driven highways.

We hope the perspectives offered in the pages that follow will help you navigate these changes in the most efficient way possible. So please, buckle up and join us as we race faster into the future, together.

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The future of mobility: What's next? Tomorrow's mobility ecosystem—and how to succeed in it

By Scott Corwin, Nick Jameson, Derek M. Pankratz, and Philipp Willigmann

Introduction

Ben is exhausted. It's 9 o'clock on Friday evening, he's been at his desk for 13 hours, and he's clocked more than 70 hours this week.

All he wants is a quick bite to eat and to head home, as quickly and painlessly as possible. He pulls out his smartphone and scans the options that his mobility app suggests. Train or bus? Too many stops. A carpool vehicle? He's in no mood to make small talk with strangers. He opts for his own autonomous taxi, price be damned, and tacks on his standard order from the local pizzeria.

Watch Ben's journey

www.dupress.com/collection/future-of-mobility

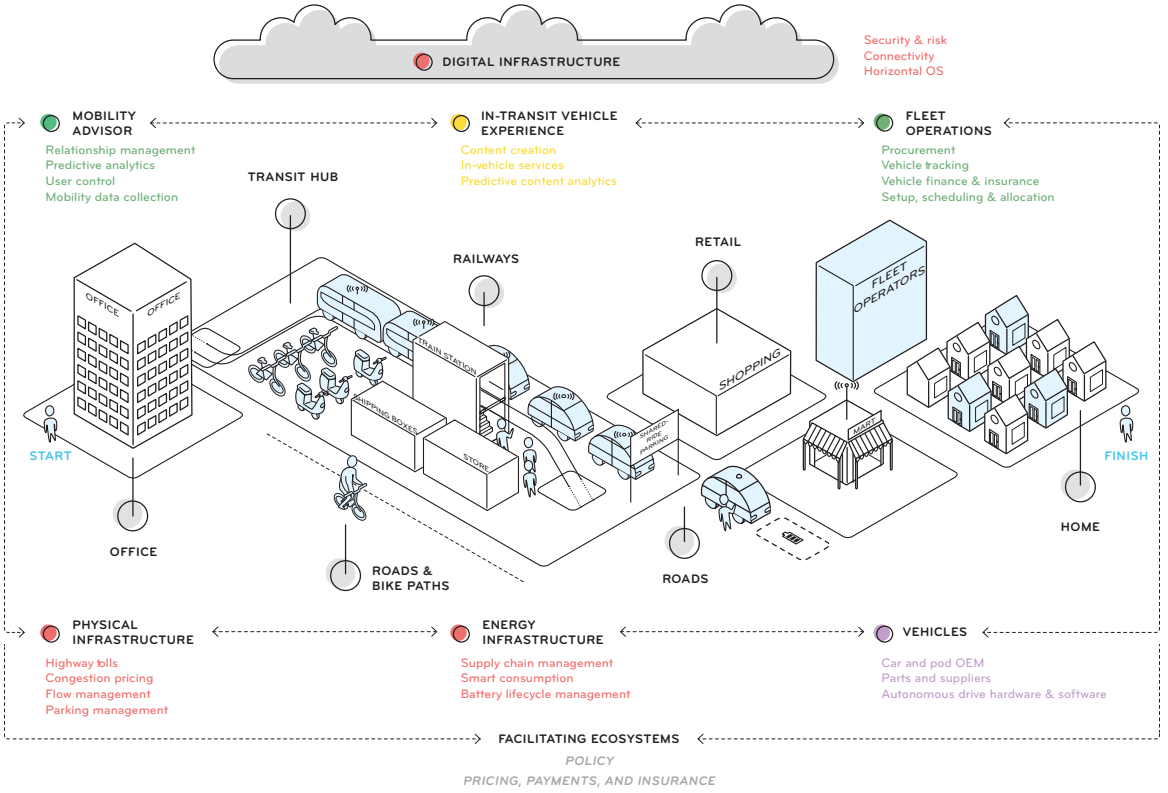
The small electric car—no driver—picks him up a few minutes later, just as Ben steps through the front door and onto the sidewalk. His slice (with extra onions) is still steaming when he opens the pizza box sitting on the car's table; the taxi picked it up moments before Ben climbed in. He settles in and enjoys an episode of his favorite guilty-pleasure reality show that the car has cued up for him. The cost of the whole trip is instantly deducted from his account. Twenty minutes later, he's at his apartment door. Half an hour after that, he's fast asleep, dreaming about his plans for the weekend.

Placing bets on the future: New opportunities to create value

Of course, individuals' transportation needs are nearly as idiosyncratic as their fingerprints. However, it is likely that enabling a seamless and potentially intermodal journey will require a future mobility ecosystem that is much more complex than today's extended automotive industry. New opportunities will emerge to deliver the diverse experiences that customers like Ben demand.

Companies will look to design new products, services, and solutions that enable multiple modes of travel simultaneously. The alternative is to accept limited future opportunities in a more diverse mobility ecosystem. Both incumbents and disruptors are beginning to stake out positions, and in the process, providing the contours for how that ecosystem might look. The first step for companies looking to create value is to identify their goals and the capabilities required to succeed in tomorrow's ecosystem.

Figure 1. The future mobility ecosystem and required capabilities



Vehicle development

The development and manufacturing of cars (and trucks, buses, trains, and bikes) will continue to provide a critical source of value. But like the mobility ecosystem as a whole, the car-making business will be more complex than ever. New products will likely emerge, from small utilitarian autonomous "pods" to highly customized, personally owned self-driving cars. And the changes won't be limited to the passenger auto; Self-driving technology will likely infuse trains, buses, commercial trucks, and other forms of transit, demanding that developers and manufacturers evolve their capabilities.

There are complex economics in being able to manufacture vehicles similar to today's mass-produced, driver-owned cars, highly customized, personally owned autonomous vehicles, ***and*** utilitarian pods for urban environments. Manufacturers will likely require not only today's traditional supply chains, but new manufacturing capabilities that allow advanced, low-cost, efficient customization. They will need to determine if they should redesign their business model to compete in future vehicle types or to focus on one segment.

Enabling the in-vehicle transit experience

The in-vehicle transit experience will increasingly be a defining feature of the future of mobility. In the United States, drivers spend roughly 160 million hours daily traveling from point A to B.[1] That's 46 minutes per person, every day. As shared and autonomous mobility proliferate, a tremendous opportunity arises for companies seeking to sell content, entertain, and generally enhance the time spent in transit. Roughly 20 percent of UK consumers' online shopping, for example, already occurs during commutes.[2]

Infrastructure enablers

The safe and efficient movement of people and goods hinges critically on underlying infrastructure, a fact that will be just as true tomorrow as it is today. Accordingly, the important role played by providers of both ***physical infrastructure*** and ***energy infrastructure*** will persist. Transit stations, roads, highways, waterways, and public parking will become even more interconnected as customers increasingly expect multimodal transportation.

In addition to these physical assets, a parallel ***digital infrastructure*** will emerge that will be every bit as critical as roads and bridges. As data becomes the new oil, companies—including providers of telecommunications, cybersecurity, and operating systems—can capture value by providing fast, safe, reliable, and ubiquitous connectivity for all the data that the future mobility ecosystem requires.

Mobility management

Today, ride-hailing companies act as network orchestrators, connecting people requiring a service with those offering that service. Along with automotive OEMs, these companies are pursuing a more integrated set of mobility options and services.

These efforts are tangible demonstrations of the future of ***mobility management***.[3] As providers begin to set up infrastructure, autonomous technologies are tested and proven, and the in-vehicle experience improves, we are seeing indications that an integrator will emerge to connect autonomous vehicles and other modes of transit to the end consumer. Fully realized mobility advisers will look to enable a seamless intermodal transportation experience, ensuring easy access, exemplary in-transit experience, a smooth payment process, and overall customer satisfaction. They will take into consideration customer preference, traffic data, and other circumstances to arrive at the most convenient and cost-effective mobility plan—whether that entails a shared car, a train, a bike, or all.

Building a strategy for the future of mobility

Depending on your perspective, the changes discussed here—shared mobility, autonomous vehicles, and seamless intermodal transit—may seem thrilling or daunting. Any actor involved in the movement of people and goods should begin identifying ***now*** where it wants to play in the new mobility ecosystem.

Each player should analyze how and by how much the future of mobility will impact their current business or operations. The magnitude of the transformation is likely sizeable, the velocity of change is rapid, and businesses and governments will have to operate in a multistate, multimodal future that demands flexibility and adaptability. While the change may seem distant, the timeframe for adoption could shrink surprisingly quickly. Accordingly, companies should:

Determine which role or roles you aspire to in the new mobility ecosystem: While change is imminent, new opportunities will continue to emerge and expand. Amidst the ecosystem's complexity, we anticipate the emergence of distinct value creation roles.

Assess how your current capabilities match those required for future success: Not all opportunities are created equal. Stakeholders must carefully examine their own capabilities against those required to succeed in their chosen role.

Evaluate competitive intensity and be clear-eyed about how you stack up against incumbents in that space: You will not be alone in seeking to capture value in the new mobility ecosystem. Many players—both incumbents and disrupters—are already making moves to capitalize on emerging opportunities.

Develop a roadmap to build the needed capabilities: Enterprise transformation rarely happens overnight and takes time and planning. Understanding the broader ecosystem and the required capabilities will help companies and governments better lay out their path to success, whether that be through acquisition, partnership, or internal development.

Change is coming soon—and the extended automotive industry will have to rapidly adjust to rising consumer expectations. As elements of the new mobility ecosystem emerge, from car-sharing apps to self-driving vehicles, it's hard ***not*** to speculate how advanced transportation technology might change.

1. Estimated as avg. travel time multiplied by number of drivers. Each American travels, on average, 46 minutes daily; see AAA, American driving survey: Methodology and year one results, May 2013–May 2014, April 2015, http://newsroom. aaa.com/wp-content/uploads/2015/04/REPORT_American_Driving_Survey_Methodology_and_year_1_re- sults_May_2013_to_May_2014.pdf. There were 214 million licensed drivers in the United States in 2014; see Federal Highway Administration, "Licensed drivers, vehicle registrations, and resident population (in millions)," Highway Statistics 2014, www.fhwa.dot.gov/policyinformation/statistics/2014/dv1c.cfm.
2. Zapp, "Commuters on track to spend £9.3 billion this year via smartphones and tablets," February 7, 2015, www.zapp.co.uk/sites/default/les/Commuter%20Commerce%20Press%20Release%20.pdf.
3. John Hagel, "Navigating a shifting landscape: Capturing value in the evolving mobility ecosystem," Deloitte University Press, January 7, 2016, http://dupress.com/articles/future-transportation-technology-mobility-ecosystems/.

The urban optimist: Daniel Doctoroff on the future of cities

By Scott Corwin

To Daniel L. Doctoroff, chairman and CEO of Sidewalk Labs, cities are more than an aggregation of people and buildings. They're opportunities for innovation that can improve the quality of urban life for citizens, governments, and businesses. Sidewalk Labs, a subsidiary of Alphabet, develops products to address "big urban problems." Dan is no stranger to tackling big-city issues: Prior to founding Sidewalk Labs, he was president and CEO of Bloomberg LP and served as deputy mayor for economic development and rebuilding for the City of New York in the Bloomberg administration. Recently, Scott Corwin, managing director and leader of Deloitte's Future of Mobility practice, sat down with Dan to get his perspectives on the future of cities.

Scott Corwin: From your perspective, where are cities today?

Dan Doctoroff: In the most successful cities, there are supply and demand imbalances that produce crises of affordability and inequality. At the same time, many cities are wrestling with deep financial problems. In the less successful cities, you're seeing depopulation and a massive reduction in services, which are leading to crises like what happened in Flint, Michigan. You can look at cities today and say, for the best cities, it's tough, and for cities that are suffering, it's worse.

On the other hand, I believe there is a very powerful case to be made for optimism. We're on the threshold of a rare era of technological innovation in cities—one that has the potential to fundamentally alter quality of life across almost every dimension.

SC: Can you put this era of technological innovation in historical context?

DD: When you look back over the past 200 years and you think about the formation of the modern city, there have been three periods with the kind of impact that we may be beginning to experience now.

The first was the invention of the steam engine, which brought people and goods to cities across long distances and enabled them to become industrialized on a scale that was not possible before.

Second, in the late 1880s, the electric grid made it possible to light up cities 24 hours a day and to travel more easily on streetcars and subways. It also verticalized cities with the elevator and ultimately enabled modern communications.

The third, in the early part of the 20th century, was the automobile. That forced cities to completely reconceive space to accommodate roadways and parking and made it easier to flee cities, which hollowed out the urban core.

Each invention fundamentally altered city life. In 1880, the fastest vehicle was pulled by a horse and the best lighting was produced with kerosene. By 1940, the automobile was fully integrated into urban life.

It's clear that we really haven't had a revolution in cities since 1940. So what happens now? I think we're on the verge of a fourth technological revolution, which will result from a combination of digital networked technologies.

SC: What are these technologies, and have they already started coalescing to produce change?

DD: The first is ubiquitous connectivity, which we are rapidly approaching. The second is sensing—and by sensing, I mean things like location services, specialty sensors, cameras—which gives us the capacity to measure what's going on in real time. The third is social networks. Social networks are important because they increase our capacity to trust wider circles of people, places, and things, not just because we can get information about them, but also because people are rating them. The next one is computing power, which helps the average person understand the implications of data and gives them the ability to understand it in new ways (through artificial intelligence and machine learning). And the fifth is a set of technologies, like 3D printing and robotics, which will enable us to rethink the design and fabrication of buildings and spaces. The combination of those technologies will make the city of today unrecognizable in 2050 or 2060.

The real opportunity will come when these technologies get integrated into the physical environment. That's when we will begin to see real growth in productivity and meaningful change in quality of life.

SC: You're arguing that once you integrate this set of foundational technologies, you would be able to provide the same quality of life at a lower overall system cost. Is that right?

DD: Yes, I believe the integration of these core technologies will have five core impacts on urban environments.

The first is greater efficiency from sharing assets: space, infrastructure, but also less tangible ones such as knowledge and time. The second is a more personalized world: Our environment will learn about us, and we will learn about it in many different ways. The third is a greater sense of community: As we pool and share community resources, the feeling of belonging to a community grows stronger. The fourth is using real-time monitoring to get a better sense of what's happening and to hold people accountable, so that we can potentially understand the real cost of externalities. Last, more adaptability: Cities can become more flexible and adapt to the needs of their residents.

The biggest change in the digital networked age is likely to be centered on mobility. Deloitte has done some of the best research on the economics of shared autonomous vehicles (AV).[1] An average vehicle is used 3 percent or 4 percent of the time, and it is the second-highest expense for an average American family making $55,000 a year. Now imagine a place that has only autonomous vehicles. At Sidewalk Labs, we've actually modeled an all-autonomous environment, and we expect that an average family would spend about half as much money on transportation as it does today. And putting $5,000 back into the pocket of a family could be the difference between struggling to get by and being able to afford things that seem out of reach today.

However, it isn't just about money. AV-only environments will be safer, meaning the time-starved parent can feel confident allowing her child to get home from school safely, potentially saving precious time. We will also be able to save on space. Parking and separated roadways take up 30 percent of a city's available land, but we think we can dramatically reduce that, creating more open space and, ultimately, improving health outcomes.

SC: How do you see all of these foundational technologies and impacts converging? What is the catalyst for change for this new era? It obviously won't be the same in every city.

DD: I think we will see that initially you don't need an idea to be successful in every city. Instead, you need to make something a success in one city. Once it is proven to be successful there, other cities are more likely to adopt the idea.

I saw this happen with the High Line when I was deputy mayor of New York. We opened the High Line in early 2009 and within a year, there were 36 high lines under development around the world.[2] You don't need to get something adopted everywhere; a good idea will follow its own path to adoption.

SC: So how do you see friction playing out between urbanists, preserving some vision of what life in cities is supposed to be like, and technologists, looking at what the technology can do? Where do they run into each other?

DD: The greatest danger to preventing the transformation of cities is the issue of data and privacy. Ubiquitous connectivity is at the center of this opportunity, because how you harvest that data—while protecting privacy—is ultimately the key to the system, right?

Currently, we do not have agreed-upon principles or protocols to manage this issue. We recognize that in our private lives, we are giving out lots of data in exchange for services. Sometimes we do it knowingly, sometimes we do it tacitly. Some places make it easier, some places make it harder, but we really haven't begun to confront the issue of data privacy in public spaces. So this integration of physical and digital resting on a foundation of data will create a debate, and that's a good thing. We've got to be able to have those conversations as a society.[3]

SC: Your optimistic view of the future of cities depends upon integrating technologies to create the digital network era. Can you really see that coming to pass?

DD: Yes, I am truly optimistic about the future of cities. When I think about a fully connected city with integrated data, I start thinking about the implications on health care, education, public safety, and other parts of urban life. I think we're going to see transformative change because cities will better understand what's happening around them and apply those insights to better anticipate and prevent problems we can't even see today.

1. For deeper insight into Deloitte's perspectives on the future of mobility, see our complete collection of research at http://dupress.deloitte.com/dup-us-en/focus/future-of-mobility.html.

2. Owned by the City of New York, the High Line is a public park on the site of an old railway line. http://www.thehighline.org/about.

3. For more on the relationship between companies and customers in an increasingly connected age, see Michael E. Raynor and Brenna Sniderman, "Power struggle: Customers, companies, and the Internet of Things," *Deloitte Review* 17, July 27, 2015, https://dupress.deloitte.com/dup-us-en/deloitte-review/issue-17/internet-of-things-customers-companies.html.

Making cities smarter: How citizens' collective intelligence can guide better decision making

By William D. Eggers, James Guszcza, and Michael Greene

The wisdom of the crowd

Imagine that you are an urban planner charged with putting walkways in a new city park. How would you decide where to put the paths?

Several approaches come to mind: You could survey likely park users, copy "best practices" from other parks, or you could build sophisticated computer simulations to project future foot traffic.

You could also take a different approach: What if you open the park and observe the paths in the dirt naturally created by foot traffic? By using a process of discovery rather than design, you could leverage the built-in knowledge and preference of real park users to find an optimal walkway solution.

Prior to the construction of Freedom Tower in New York City, the great urban theorist Jane Jacobs suggested that the Ground Zero site scrap its existing street grid, "I was at a school in Connecticut where the architects watched paths that the children made in the snow all winter, and then when spring came, they made those the gravel paths across the green. Why not do the same thing here[1]?"

Jacobs is perhaps today's pre-eminent urban philosopher, and her modest parable exemplifies an idea common to her theories of urban design—namely, the best designs respect the wishes of actual city dwellers. Jacobs takes a dim view of the grand designs of central planners, and once urged her audience "to respect—in the deepest sense—strips of chaos that have a weird wisdom of their own [2]."

Bottom up versus top down

As important as connected devices and assets are, focusing exclusively on the hardware of smart cities leads to an incomplete vision. A large part of the promise of data science and internet technology is they enable not just smart things but smarter decisions. Three interrelated forces are at play.

The data science revolution: Thanks to mobile phones, connected cars, and wearable self-tracking devices, our lives are increasingly digitally captured. In essence, we leave digital footprints everywhere we go like children in the snow. This means that fine-grained data about preferences, behaviors, and knowledge can be analyzed to create recommendations that enable better decisions.

Behavioral economics: Data science and behavioral science are complementary. Big data points toward a solution but needs help coming up with recommendations on how to act. A key insight of choice architecture is that minor, often inexpensive tweaks to choice environments can yield outsized effects on people's actions. Behavioral design thinking, particularly when combined with data science and digital technology, offers policymakers powerful tools for achieving cities where people make smarter decisions.

Tapping into the wisdom of the crowd through technology: The internet and mobile devices enable new forms of mass collaboration. Digitally connected citizens are the ultimate "network of sensors" that enable local information to quickly get to decision makers.

Common to each of these themes is the aspiration to base decisions on detailed local knowledge and choice-preserving decision environments, and—when possible—to achieve order from the bottom up: outcomes that reflect the voluntary choices of individuals rather than outcomes imposed by planners' top-down decisions.

This doesn't mean planners and their plans aren't important—creating frameworks that tap into the wishes of individuals isn't easy. The wise planner bases her decision on the emergent order resulting from the crowd's aggregated knowledge and preferences. The smart city doesn't decree smart outcomes, but rather it creates a platform for better decision making.

Behavior change by design: The power of choice architecture

A city gets smarter only if these data and analysis result in better decisions and outcomes for residents. That's where behavioral insights—the science of choice architecture and behavioral "nudges"—comes in. We view behavioral science and data science as natural complements: Predictive models can be used to flag the cases cases most in need of attention of attention; behavioral insights provide the tools for prompting the desired behavior change.[3]

In San Francisco, Harvard University economist Mike Luca worked with Yelp to put information into the hands of diners.[4] For every restaurant rated in the bottom 5 percent for hygiene by the city, a "consumer alert" warning on the Yelp app itself would give would-be diners important information precisely when it was most useful—at decision-making time. Putting this sort of public information into citizens' hands through technology can "nudge" them into making more fully informed decisions.

Until a decade ago, Lake Shore Drive had one of Chicago's most dangerous stretches of road. To reduce accidents near the Oak Street curve, the city created a visual illusion by painting a sequence of white lines on the pavement, each shorter than the previous one, on the approach to the dangerous curve. The succession of shrinking lines gives drivers the feeling they are accelerating, prompting them to slow down and take the curve at a safer speed. City traffic engineers reported 36 percent fewer crashes in the six months following the introduction of the lines.[5]

Citizens as sensors

Technology's true power is its ability to facilitate the process of cocreation. The city of Boston partners with Waze to use driver data to reduce traffic congestion: Waze forwards data to the city's traffic engineers, who blend them with data gathered from sensors and cameras to make real-time adjustments to traffic signals. As with any successful collaboration, both partners benefit. "We also provide information back to Waze on changes that we've made in real time, but also any known changes that we have coming up that are planned," says Gina Fiandaca, the Boston Transportation Department commissioner. [6]

Another way the citizen-as-sensor concept has made Boston smarter is with the Street Bump app [7]. Using sensors in phones to map bumpy roads, the app empowers drivers to report potholes themselves. As a side benefit, useful insights have emerged—for instance, unexpectedly, users reported sunken manhole covers four times more often than potholes. Armed with this knowledge, the city worked with utility companies to fix 1,250 of the worst covers.[8]

Internet technology not only enables the harvesting of data from connected citizens, it offers novel ways of harvesting ideas and opinions to achieve a literal form of "the wisdom of crowds." Wiki surveys, which evolve based on the input of responders, are a prime example.

Wiki surveys are adaptable, in that they elicit new possible survey answers from survey takers.[9] As a result, it is possible, and indeed common, for "answers" that hadn't occurred to the survey designers to land at the top of the list. New York City launched its first Wiki survey in October 2010 in conjunction with a series of community meetings while putting together PlaNYC 2030, a citywide sustainability plan. City officials asked: "What do you think is a better idea for creating a greener, greater New York City?" They seeded the survey with 25 answers. Over about four months, 1,436 respondents contributed 31,893 responses and 464 new ideas—including eight of the top 10 ideas. Only two of the top 10 were among the original seed ideas.[10]

Jacobs's ladder: Smart citizens, smart cities

The promise of the smart city should be about more than Wi-Fi hotspots and talking trashcans. Optimizing physical infrastructure to deliver smart mobility, smart city services, and smart energy is part of the smart city story. But a smart city should also use technology to promote better decisions.

Smarter decisions come about by using data science, behavioral science, and digital technology to empower better, less centralized, and more empirically informed decision making. Installing sensors that collect data for optimizing the performance of physical devices is part of what it takes to achieve the smart city. Going the last mile involves using technology to tap into the city's greatest asset: its citizens.

This means shifting the focus away from top-down plans for optimizing physical infrastructure and making sure to include people in the smart city model. The ultimate goal is to make cities a better place to live—not just a more efficient deliverer of infrastructure. People-centric design thinking promotes an emergent order and collective intelligence—the sidewalk ballet—and is central to Jane Jacobs's view of cities.

The race to autonomous driving: Winning American consumers' trust

By Craig Giffi, Joe Vitale, Ryan Robinson, and Gina Pingitore

Introduction: A self-driving future

Science fiction visionaries have long promised futuristic transportation options. While jetpacks and teleportation are still distant, the technologies are finally in place to make self-driving cars a reality.

After decades of investment, today's vehicles offer many partially autonomous features. Emerging technologies could enable even more vehicle-to-vehicle and vehicle-to-infrastructure connectivity, making the leap to fully driverless cars even shorter. In fact, executives from several leading automakers foresee advanced self-driving technology being available by 2021 or sooner.[1]

Although opinions differ on the pace at which automakers and service providers could introduce autonomous car technology and the impact of shared vehicle ownership, most agree that the stakes are high. With approximately $2 trillion in annual revenues, the extended US auto industry is one of the most important in both the US and global economies.[2]

As part of Deloitte's continuous assessment of consumer behavior, we recently surveyed more than 22,000 consumers in 17 countries to shed light on their preferences and help automakers prioritize and better position their R&D strategies and investments.

The good news is twofold: US consumer interest in advanced vehicle automation has increased since 2014, especially among younger generations. More importantly, all US consumer segments surveyed agree on what's most useful: safety-related technologies. Features that improve driver and pedestrian safety are perceived as much more valuable than those that enable connectivity, comfort, or even fuel efficiency.

The bad news is also twofold: US consumers' stated willingness to pay for these technologies has decreased over the last two years, putting pressure on original equipment manufacturers (OEMs) looking for ways to build enough value in these features to gain a decent return on their costly R&D efforts. Fewer than half of US consumers surveyed say they trust traditional OEMs to bring fully autonomous vehicles to market, opening the door for new entrants to gain a critical foothold at the nascent stage of this emerging shift in personal mobility.

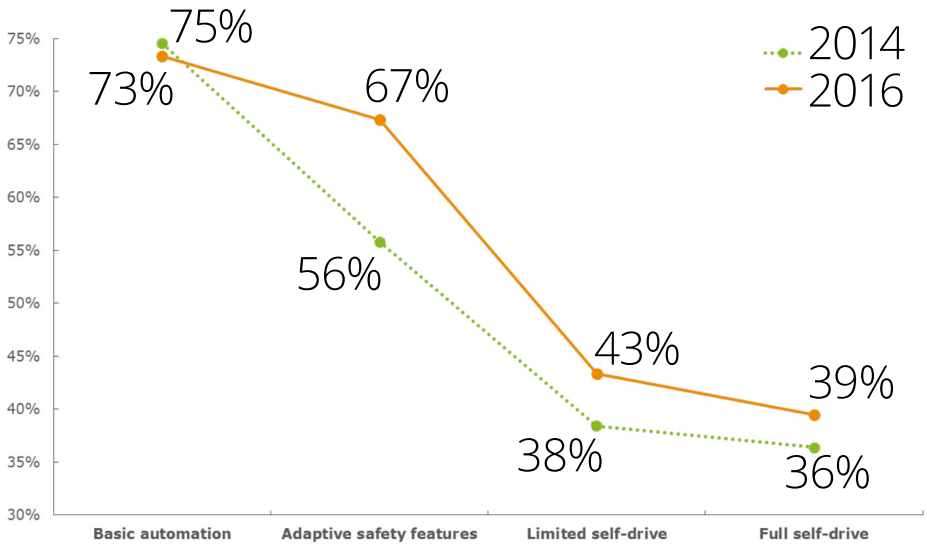
The good news for automakers

Two-thirds of US consumers want advanced vehicle technologies

Our findings confirm that interest in advanced vehicle technologies is on the rise. We asked US consumers to rate the desirability of four graduated levels of vehicle automation.[3] Compared to our 2014 study, more US consumers are interested in advanced vehicle automation features, moving beyond basic automation such as anti-lock braking or traction control to more advanced functionality in which the vehicle can assume a more proactive role with features such as emergency braking, adaptive cruise control, and lane-keeping assistance. Our findings show that 67 percent of US consumers have a strong desire for these adaptive safety features and similar automation, an increase of 11 percentage points over the 2014 results (see figure 1).

US consumer interest in both partial and fully self-driving technologies also seems to have increased, albeit more modestly. Interest in partial self-drive features such as parking assist is at 43 percent (up from 38 percent), while fully self-drive interest has risen to 39 percent (from 36 percent). Younger consumers may offer a sweet spot for automakers and tech players, as nearly

Figure 1. Percentage of US consumers interested in different levels of vehicle automation technology (2016 versus 2014)



Sample size: 2014, N=1,913, 2016, N=1,722
Source: Global Automotive Consumer Insight Platform, Deloitte.

60 percent of Gen Y/Z respondents (born after 1976) in the US indicate strong interest in both partial and fully self-driving cars.

But are consumers willing to pay?

While American consumers' interest in advanced vehicle technologies has increased, there is growing restraint in what they are willing to pay for these features. Our findings show that the amount US consumers say they will pay for various advanced vehicle technologies has declined by 30 percent compared to 2014, from $1,370 to $925.

Perhaps more concerning, a significant share of American consumers suggest that the auto industry should bear the entire cost for bringing these advanced technologies to market, saying they are unwilling to pay any more for these features—even those designed to improve safety.

For the young and old, safety comes first

When investing in advanced vehicle technologies, automakers would be wise to focus on features that consumers find most valuable. Out of the 32 features tested in our study, the top five among US consumers are related to safety and include technologies that:

- Recognize presence of objects on road and avoid collisions
- Inform driver of dangerous driving situations
- Automatically block the driver from dangerous driving situations
- Automatically take action in medical situations
- Enable remote shutdown in cases of theft[4]

The forward-looking safety features topping consumer wish lists also enable cars to perform certain tasks on their own (that is, autonomous technology). So even though US consumers seem cautious about self-driving cars, they are already buying, using, and wanting many of the technologies that would make fully autonomous vehicles a reality.

Bad news for some automakers

Americans aren't that interested in service-enabling technologies. When asked for technologies they found least useful, those surveyed pointed to features that:

- Automatically pay for toll roads, parking, and priority/commuter lane fees
- Empower customers with the ability to design and personalize vehicles
- Allow drivers to control automated systems in their homes
- Enable ultra-small, low-speed, self-driving vehicles for urban environments
- Help manage daily activities

One of the main reasons these features fall to the bottom of the list is that many consumers are already comfortable using their smartphones to accomplish these tasks. They also see little added value in having them embedded in the vehicle's center stack.

What about self-driving cars?

Although the majority of US consumers surveyed think driving in autonomous vehicles would be fun and would free up time to do other things, three out of four are skeptical that self-driving cars will be safe anytime soon. However, those surveyed would be willing to try them at the point where there is an established safety record for such cars.[5]

A looming risk: Ride-hailing isn't a significant threat to vehicle ownership—yet

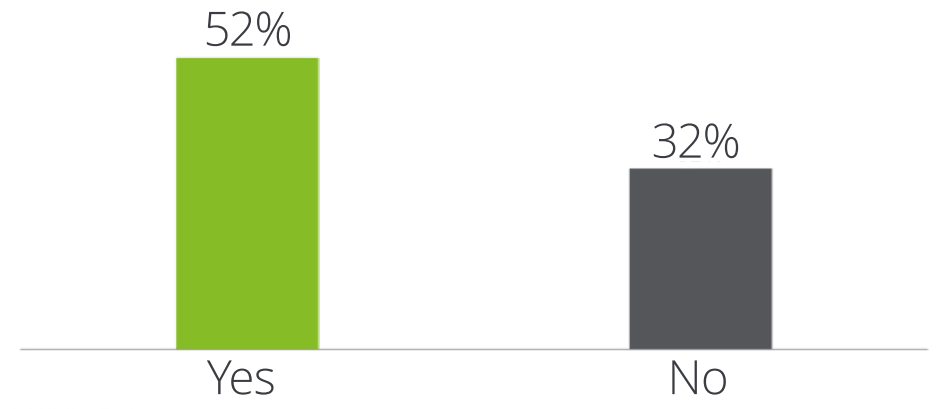
While much has been said about the meteoric rise of ride-hailing services such as Uber, the majority (77 percent) of the US consumers surveyed never or rarely use these services. For those who do use ride-hailing services, their experience so far seems to be positive, since nearly one in two US users surveyed question their need to own a vehicle in the future (figure 2). Although these services wouldn't render car ownership obsolete anytime soon, growing availability may change the playing field for auto sales down the road.

How can the auto industry adapt and thrive?

Not surprisingly, most US consumers aren't yet ready to give up complete control of their cars—or the idea of owning cars. Almost no consumers have been exposed to fully autonomous vehicles, and a key step to quicken adoption is to build confidence that autonomous features are safe. Such assurances will likely take time and effort and be the result of numerous large-scale, in-market pilots launched across multiple geographies.

Although most US consumers don't currently use ride-hailing services, current trends in population movement to urbanized areas, coupled with rising number of urbanites using ride-sharing programs, could make for a larger impact on vehicle ownership than one might think.

Figure 2. Percentage of US consumers who question their need to own a vehicle due to their use of ride hailing services



Sample size: N=792
The remaining percentage of consumers haven't thought about it.
Source: Global Automotive Consumer Insight Platform, Deloitte.

With these trends in mind, we offer five key considerations for auto industry executives:

1. **Better understand and monitor consumers' preferences and their willingness to pay**: While consumers often don't know what they want or will pay for a new technology, they can adopt and even become dependent on them quickly. It is reasonable to suspect consumers may not warm as quickly as logic would dictate to the promise of vehicles that never crash or the economic benefits of sharing rather than owning a vehicle.

2. **Upside for those focusing on safety features**: Even though US consumers may be a bit leery of autonomous cars, the advanced technology features they do want are on the spectrum of self-driving capabilities. Marketing these technologies as safety features is a good way of getting Americans comfortable with various aspects of vehicle autonomy and is consistent with their current preferences and willingness to pay.

3. **Prioritize R&D investments**: Safety technologies are more important than fuel efficiency technologies, which are themselves more appealing to US consumers than pure self-driving technologies.

4. **Tap into the broader innovation ecosystem, and consider new partnerships**: Typical automotive product development timelines are long, even for traditional vehicles. This equates to astronomical costs, which are likely difficult to sustain over the long term, particularly in a global environment characterized by hyper-competition and challenging profit margins. As such, automakers would be well served to develop alliances and investigate potential synergies with suppliers, tech providers, and fellow carmakers in an effort to reduce costs and streamline advanced R&D efforts.

5. **Recognize the significant generational and geographic differences in consumer preferences**: All of our recently collected global consumer data suggest that consumers' preferences vary substantially when looked at through a generational or geographic lens. This suggests the need for a much more detailed analysis to understand consumers and new, more individualized ways of targeting, marketing, and selling to them.

The rise of mobility as a service: Reshaping how urbanites get around

By Warwick Goodall, Tiffany Dovey Fishman, Justine Bornstein, and Brett Bonthron

If Netflix's business model were applied to urban transportation, how might that change the way city dwellers get around?

That's the question at the heart of an ambitious initiative taking shape in Finland's capital, which aims to make it unnecessary for any city resident to own a private car by 2025.

Since 2016, Helsinki residents have been able to use an app called Whim to plan and pay for all modes of public and private transportation within the city. Anyone with the app can enter a destination, select his or her preferred mode or modes of getting there, and go.

The goal is to make it so convenient for users to get around that they opt to give up their personal vehicles for city commuting, not because they're forced to, but because the alternative is more appealing.

Helsinki's vision represents the next revolution in mobility: mobility as a service (MaaS). At its core, MaaS relies on a digital platform that integrates end-to-end trip planning, booking, electronic ticketing, and payment services across all modes of transportation; public or private.

By calculating how best to get individual users where they're going based on real-time conditions throughout the network, and facilitating seamless mobile payment, MaaS starts to move us toward a more user-centered mobility paradigm.

What's fueling global interest in MaaS

The conceptual embrace of MaaS by transportation planners and operators is, in many ways, a natural evolution of two key trends.

First, people no longer view transportation through the prism of "either/or": *Either* you fall into the "more roads" camp *or* you favor "more transit." The problem that confronts transportation planners everywhere is that adding new infrastructure capacity to relieve congestion—be it roads or transit—is notoriously slow and costly.

Even if timelines could be collapsed and resources were plentiful, there's little appetite for turning cities into even larger parking lots than they are today. The push is firmly in the opposite direction. People want to make cities more livable, and many believe that means making them less vehicle-centric.

Second, consumers have increasingly embraced new mobility options and apps over the last decade:

- Carsharing had nearly 5 million members worldwide in 2014, up from around 350,000 in 2006, and is projected to exceed 23 million globally by 2024.
- There are more than 1,000 public bikeshare schemes in more than 50 countries—in 2004, only 11 cities worldwide had such programs.[1]

> An important factor in making MaaS successful will be getting all of the players to work together.

- Ride-hailing services have seen similarly rapid growth. In six years of operation, Uber's global footprint has expanded to more than 500 cities in more than 70 countries.[2]
- Journey planning apps, which help users identify and compare different modal options for getting to their destinations, have become commonplace, with local and global offerings available in every city.

From mass transit to MaaS transit: The core elements of the MaaS ecosystem

Infrastructure

MaaS is a data-driven, user-centered paradigm, powered by the growth of smartphones. To work effectively, MaaS requires:

- Widespread penetration of smartphones on 3G/4G/5G networks
- High connectivity levels
- Secure, dynamic, and up-to-date information on travel options
- Schedules and updates
- Cashless payment systems
- Thoughtful integration of physical infrastructure that enables transfer between transportation services
- Bike and carsharing spaces at stations
- Data providers

Users access MaaS through a platform—either a multimodal trip-planning app or a webpage. Competition among these platforms is fierce. A good one identifies a range of transportation options and offers real-time traffic updates. Consumer adoption depends on having good coverage, which can vary greatly.

A third-party data provider manages the data exchange between service providers and end users, providing the application programming interface (API) gateways, analytics, and reporting. Because individual service providers are not likely to share their app data, having a third party involved can remove some of the barriers to cooperation that would otherwise arise. [4]

Transportation operators

Essential to any MaaS offering are the public transportation operators. Demands to expand service delivery have driven many transportation agencies to introduce new modes of travel, such as bikesharing, or to join up with complementary modes, such as carsharing.

Gaps in public transportation services have fueled a growing army of small-scale private providers, each offering a specific service: parking, carpooling, ride-hailing, or on-demand bus rides. Typically, each operator requires its own app, with a separate interface and payment mechanism, and each service maintains its own customer relationships.

Trusted mobility advisor

The newest and most integral component of MaaS consists of third-party aggregators. Using an asset-light model, the trusted mobility advisors link the services of various private and public operators, arranging bookings and facilitating payments through a single gateway.

The evolution of MaaS

MaaS is at a very early stage in its development, with much innovation and experimentation underway. Meanwhile, incumbent transport operators are beginning to understand that their business models will likely need to change as they seek to harness technological advances that enable a wider range of choices, and a higher level of responsiveness. The number of private-sector providers may very well also increase, seeking to fill the gaps in local transportation services.

An important factor in making MaaS successful will be getting all of the players to work together. Private sector participants might join the movement in search of profits, while government agencies could seek the public policy benefits that stem from reduced congestion. Participants will gain these benefits only if they collaborate.

Making MaaS materialize

Making MaaS a reality requires building a multi-stakeholder consortium of government and private-sector players.

Set the scene

One of the important roles for government in MaaS development is to bring everyone to the table.

Government should define the vision and set the metrics by which success is measured, and encourage investments in programs. Moreover, the public sector can encourage behavior that aligns to broader public policy goals, such as reducing congestion or traffic accidents.

Protect the public interest

Governments should play an important role in ensuring that the new transportation environment doesn't compromise safety or security. Safety guidelines should address the new technologies, while anticipating future developments.

Government entities can use their power to foster equity in transportation provision, ensuring geographic coverage and accessibility, as well as serving low-income and underserved populations.

Finding the regulatory sweet spot is key. Too much regulation and the private sector may find it difficult to innovate or participate; too little regulation and the public interest is not served.

Promote data accessibility

Any successful multimodal MaaS solution would require access to the public transit system's route and real-time location data. According to City-Go-Round, only 292 transit agencies of the more than 1,000 that exist globally have open data, though more are being added regularly.[5]

Participate as a good citizen

The private sector can take ownership of specific programs run on behalf of cities. This serves larger governmental aims while offering companies some branding opportunities, increased visibility, and a chance to get some business out of the association.

In London, the bike rental scheme has been sponsored by large banks, which contribute around 10 percent of the operating costs plus an additional amount toward expanding the coverage. The result is a win-win for both parties: the city is able to offer a wider array of mobility options and the cost is partly borne by a private company. The bank, in return, benefits from the advertising and gets access to the data of everyone signing up for the service.

Looking ahead: Roadmap to the future city

MaaS might be at a nascent stage, but it's a model that most people already have experience with. Take a web-based travel aggregator, for example. It offers a range of flight options based on a user's preferences: Travel directly? Cheaply? Users then add on a range of other services: hotels, car rental, and so on.

There are three reasons to believe MaaS could quickly evolve beyond the pilot stage:

- Simply adding more roads, more trains, and more parking garages is unlikely to solve the problems of congested urban areas.
- Major capital investments are not feasible for cities confronted with difficult fiscal situations. With more people moving into cities, those problems will almost certainly worsen without a unified transportation solution.
- Non-networked forms of transportation don't meet the needs of the modern urbanite. In many cities, getting from point A to point B is difficult at nearly any time of day, and sometimes downright miserable.

MaaS represents the next evolution in mobility. If it's not there already, it's coming to a city near you.

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Framing the future of mobility: Using behavioral economics to accelerate consumer adoption

By Derek M. Pankratz, Philipp Willigmann, Sarah Kovar, and Jordan Sanders

The user adoption hurdle

The extended automotive industry is in the early stages of a potentially transformative evolution. An evolution where today's personally owned, driver-driven vehicles will likely travel alongside shared and self-driving cars. The speed with which this future vision arrives hinges on both technological and regulatory advances, and on how quickly consumer expectations and behavior shift.

In this article, we explore how human behavior can lead us to delay or forego adopting new technology (in this case, shared and autonomous vehicles), even if that technology provides demonstrable benefits. While research in behavioral economics and social psychology has revealed deep and consistent biases that can lead to suboptimal choices, it has also uncovered ways to potentially overcome these mental limitations. By constructing choices and framing new mobility options in ways that encourage adoption, companies, governments, nonprofits, and others can help ensure that the future of mobility arrives sooner rather than later.

The promise of the future of mobility

Converging technological and social trends seem poised to dramatically reshape the ways that people and goods move. The confluence of ride- and car-sharing, and the development of fully autonomous vehicles could transform the nature of mobility.

There could be a myriad of societal benefits. Traffic congestion could ease; air quality could improve and energy consumption decline; and vehicle accidents could fall dramatically.

At the individual level, changes could lead to fewer white-knuckle commutes, more efficient commutes, and less congestion.

But even if the benefits of a world of shared self-driving cars seem self-evident, companies should not assume that consumers will reach a similar conclusion. In fact, peoples' cognitive biases suggest that many individuals may be reluctant to relinquish their personally owned and driver-driven vehicles.

Pumping the brakes: The cognitive biases that could slow the future of mobility

For decades, researchers have documented ways in which human decision-making departs from classic assumptions of rational, cost-benefit calculation.[1] Some salient biases that could lead customers to balk at adopting such technological and service innovations are below (see figure 1).

Gains and losses: Loss aversion, endowment effects, and the status quo bias. The fear of loss typically looms larger than the anticipation of perceived gains, causing us to overweight what we might give up relative to the potential improvements created by some new choice.[2] Because we tend to overvalue current benefits and undervalue potential gains, we also strongly resist change.

Combined, these cognitive biases can be a powerful force for inertia. The most ambitious view of future mobility envisions at least some foregoing personally owned, driver-driven cars in favor of on-demand autonomous vehicles. That means surrendering all of the real or perceived advantages from the car sitting in the garage in favor of some lesser-known alternative.

Figure 1. Summary of select biases and their effects

Cognitive bias	Description	Impact on future of mobility adoption
Loss aversion	Overvalue losses and undervalue gains	Consumers overvalue their personally owned, driver-driven vehicles relative to future types of shared and/or autonomous mobility
Endowment effect	Overvalue items we already possess	
Status quo bias	Overvalue the current state relative to alternatives	
Risk miscalculation	Overweight risk of unknown and "dreaded" outcomes	Consumers perceive shared and autonomous mobility as riskier than it objectively is
Optimism bias	Overestimate own abilities or underestimate risk of something bad happening	Consumers fail to perceive the safety advantages of autonomous vehicles
Availability heuristic	Overemphasize likelihood of certain signature events	Consumers fixate on rare negative outcomes (e.g., crashes, cyberattacks) associated with the future of mobility

The dreaded unknown: Evaluating risk. We are generally quite poor at accurately assessing risk, at least as it has been traditionally defined by economics. Most non-experts' perceptions of risk are impacted by two dimensions of a possible event: the degree to which the risk is ***unknown***, and the degree to which it instills ***dread***.[3]

The risk posed by autonomous vehicles may be relatively unknown to the buying public, and regardless of the testing done by regulators or carmakers, the underlying technology of a self-driving car will likely remain mysterious to the average consumer. Likewise, the very nature of an autonomous vehicle makes it fundamentally uncontrollable (by the passenger, at least), which means customers are likely to see riding in them as particularly risky.

Even as consumers may perceive self-driving cars as much riskier than they objectively are, they are also likely to downplay the risks inherent in their own driving. Study respondents persistently demonstrated ***optimism bias*** and the tendency to overestimate their own abilities or underestimate the probability that something bad could happen to them. Most drivers routinely believe they are safer and at lower risk of being involved in an accident than the average driver, meaning they are also less likely to adopt an autonomous vehicle for safety reasons, regardless of the statistics.[4]

The availability heuristic. Exacerbating these risk-based biases is our tendency to overemphasize the likelihood of certain events.

For consumers contemplating transportation options, this availability heuristic could lead them to balk at new mobility choices since the most familiar and salient examples are likely to be those reflecting negative experiences. In the case of autonomous cars, consumers could focus on the rare instances of cyberattacks or system failures leading to a crash, underemphasizing the much greater odds of being involved in an accident in a human-controlled car.

Stepping on the gas: Overcoming psychological barriers to the future of mobility. The significant investments being made in the future of mobility could be undermined without a careful and thorough consideration of how consumers might perceive and adopt these new technologies and services. Below are a handful of lessons from behavioral economics that can be used to "nudge" consumers and help overcome cognitive barriers to adoption.[5]

- **Recast losses as foregone gains and gains as foregone losses**.[6] Because losses are typically overvalued relative to gains, advocates might stress what a consumer would miss by ***not*** choosing an autonomous vehicle. Similarly, negative framing can also be effective.[7] So instead of promoting that "Buying a driverless car saves lives," advocates might consider a variation of "Not buying a driverless car costs lives."
- **Aggregate the costs and risks**. To overcome potentially skewed perceptions of loss and risk, consider expanding the relevant timeframe or pooling the costs.[8] Proponents of shared and autonomous mobility could emphasize the average time lost in an entire year to commuting (31 days for so-called "mega commuters"), rather than the few minutes that accrue every day.[9]
- **Create social proofs**. We often look to the behavior of others for clues as to the correct course of action. Such "social proofs" can serve as powerful motivators, and messaging that invokes peers is often effective in changing behavior.[10]
- **Set default options**. Creating pre-selected options can have a powerful effect on what we ultimately choose.[11] To encourage uptake, service providers can make shared or autonomous mobility the default option.
- **Make autonomy a peripheral, rather than a core feature**. In a study of car "autopilot" technology, survey respondents were presented with one of three scenarios: an integrated self-driving system that is the only way to control the vehicle; an integrated system that also had the option of human control; and a vehicle with a plug-in accessory that offered self-driving capabilities. Those presented with the latter condition (add-on option) were two to three times more likely to sign up for a test drive.[11-]

Shared mobility and autonomous vehicles offer many potential benefits, and while important developments emerge near daily, the future of mobility still lies ahead of us. How quickly that future emerges is likely to depend not only on the merits of emerging technological solutions, but also on how well key players understand and address consumers' cognitive biases.

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