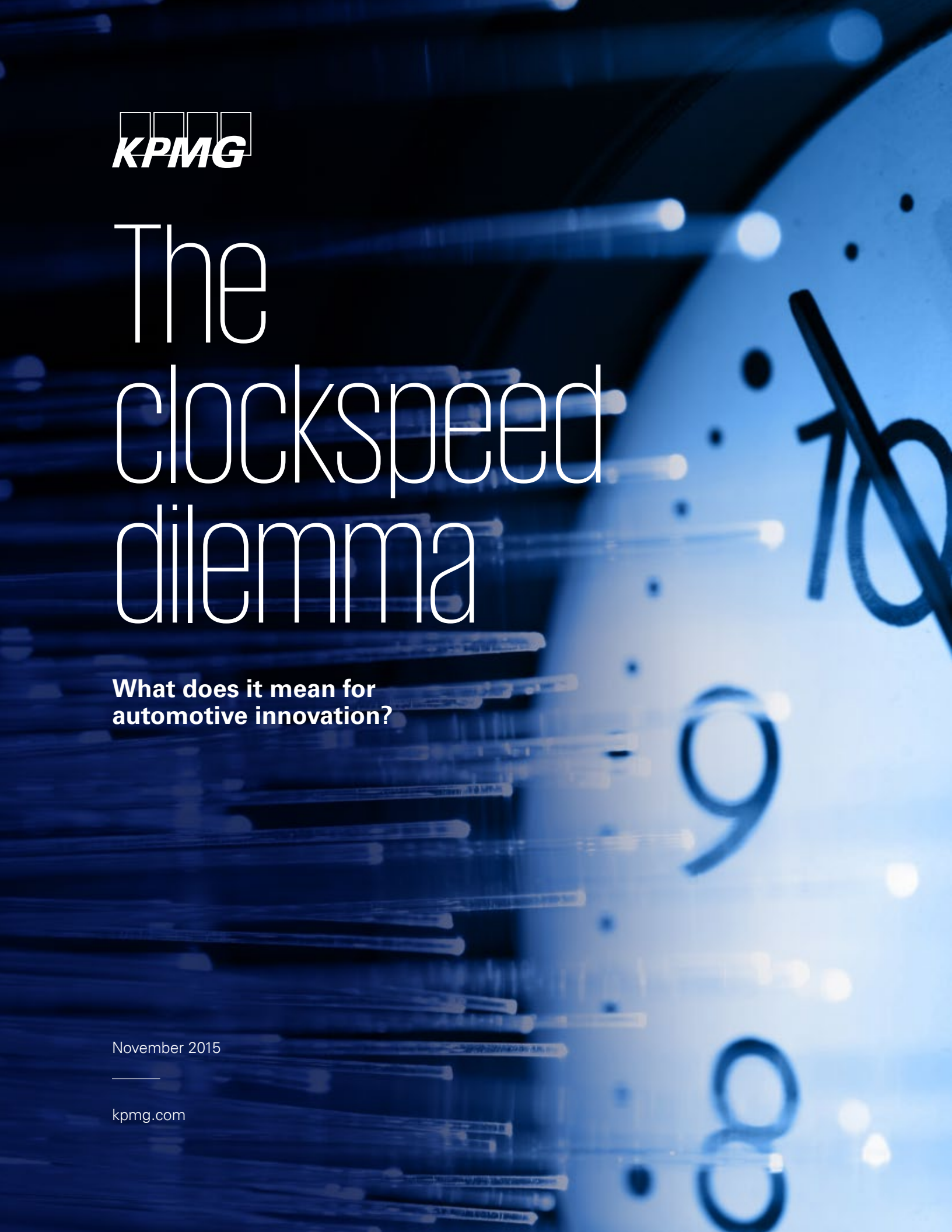

KPMG

The clockspeed dilemma

What does it mean for automotive innovation?

November 2015

kpmg.com

Get ready for light speed...

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A message from Gary Silberg

In last year's groundbreaking paper Me, My Car, My Life, we described a convergence of consumer and automotive technologies and the rise of mobility services. Together with the development of autonomous vehicles, they are revolutionizing the industry and the way we live our lives.

This year, we want to examine how the automotive industry must innovate in response to these transformations.

In the last 100 years, the auto industry has been at the forefront of innovation, building a powerful base of knowledge along the way. From the Model T to mass production to automatic transmissions and beyond, the car has evolved into an amazing blend of road machine and sophisticated computer. Add to that a dazzling array of the latest technologies—sensors, cameras, radar, lidar, and sophisticated chipsets. It's clear we have witnessed profound change.

And yet, despite all this astonishing innovation, we believe the next decade will produce as much change as the previous century. In less than five years, cognitive computing has advanced from a novelty to a commercialized means for solving problems. In 2014, bioengineers developed a circuit modeled on the human brain: 16 "neurocore" chips that simulate a million neurons and billions of synapses, able to process information 9,000 times faster than a PC and with 40,000 times the energy efficiency. In April, IBM declared that we have begun "a golden era" that will lead to the development of a practical quantum computer. Combined with near-record levels of capital investment in start-ups, the picture becomes clear: we are entering a time of accelerated innovation, at a pace unprecedented in modern history.

For companies to thrive in this new environment, they must solve what we call "the clockspeed dilemma." What is the clockspeed dilemma?

Albert Einstein's theory of relativity makes the point simply enough. Einstein taught us that time is relative.

It sure is in the auto industry. Car companies obey a pace—a clockspeed—required of capital-intensive powertrain plants, stamping plants, and assembly lines, to ensure cars work at Six Sigma quality every time and all the time, from -40 to

Imagination is more important than knowledge. —Albert Einstein

130 degrees Fahrenheit. Now they must also embrace a far faster clockspeed—actually, multiple faster clockspeeds. The faster clockspeeds are the result of new players entering the ecosystem, from technology giants to start-ups. Some of the new competitors operate at a much larger economy of scale. All of them fuel customer demands for cars to be repeatedly new, exciting, and sexy while still holding to the standards of Six Sigma quality. Thus the clockspeed dilemma: the need to serve two different paces at once.

Source: Cosmic Religion: With Other Opinions and Aphorisms (1931) by Albert Einstein, p. 97

The auto industry must reconcile these two different rates of change. It must act as if it were simultaneously in two worlds, moving at two different speeds. To do so is what successful innovation now means.

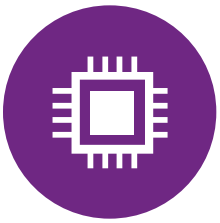
It is inspiring. Innovation in the current auto space will transform the very nature of transportation and change people's lives along the way. But this kind of innovation is also really hard. Most organizations do not embrace imaginative solutions to problems. In fact, they stifle them. Never forget: the man who brought us relativity, quantum physics, and $E=mc^2$ was ignored and even laughed at before the world recognized him as an innovative genius. In the current environment, the auto industry doesn't have time to ignore its true innovators. It must solve the clockspeed dilemma today. If the industry does, it will be powerfully equipped to address the findings we reached from this year's research.

Gary Silberg
National Automotive Industry Leader

Key changes: Big opportunities

Seven key findings to keep your eyes on.

Personal miles will soar.
Younger and older age groups are making small changes in their mobility decisions that will drive big changes in personal miles traveled. Our models project as much as an additional trillion or more by 2050. That increase will have a profound but unknown impact on vehicle sales, car ownership models, energy demand, and infrastructure.



The tech giants and disruptive start-ups are here to stay.
The pyramid OEMs once ruled now has company at the top. Car companies are standing shoulder to shoulder with new players who can sense consumer changes and drive new technologies into the market at a very fast pace.

Welcome to the world of tailored premiums.
Our focus groups tell us premium experience might diversify according to demographics and user situation. If so, what millennials or their children think of as premium won't be the same as baby boomers today. A rolling office? A moving entertainment center? Zero to 60 in 3 seconds or less? Automakers must pay attention to increasingly tailored consumer demand.

Build flexible architecture for an ever-changing future.
To interface with all the evolving technologies, your vehicles must have a flexible architecture. Imagine what would happen if your company locked itself into Myspace rather than Facebook: no one would buy your car.

Choose your core competencies wisely.
Accept that you will never keep up with all the technological changes or compete in all areas. The ecosystem is too vast and changing, and you don't have enough capital to invest in everything.

Sense the ecosystem from its center to its farthest reaches.
It's critical that you keep up with all the innovative forces inside and outside the industry, which are rapidly and constantly transforming consumer expectations.

Embrace the value of failure.
Nobody gets it right the first time, so fail fast in small ways and learn a lot from your failures.

To create the multiple clockspeeds it now faces, the auto industry must institutionalize faster-paced innovation capacity that dovetails with its current clockspeed. We have ideas on how to do that. It's an exciting, powerful problem for the industry. Let's get to the details.

More than ever we believe the ecosystem is evolving… It is just happening faster than we expected

Who are the key players?

How and when will investments be made?

How will the balance of power shift amongst the players?

What are the competitive strategies?

Last year, we hypothesized that the structure of the ecosystem in the automotive industry was going to change. High-tech entrants and tech start-ups would match the OEMs at providing technology and revolutionizing the industry. This past year proved that is happening at a faster rate than we anticipated. New technologies are coming from every direction, so auto companies have to broaden their radar to keep pace. In the future, horsepower may matter less than processing power. Winning companies will be nimble, future-oriented, and prepared to invest in new technologies, new talent, and new strategic alliances.

The clockspeed dilemma

Customer expectations and the rise of multiple clockspeeds

The first step in solving the clockspeed dilemma is to understand the different clockspeeds that innovation and customer demand create. Of course innovations drive changes in consumer expectations, but we believe the newest consumer expectations will soon require innovation at multiple speeds. In fact they already do.

Consumers expect as a given that a car provides increasingly better fuel economy, increasingly safer experience on the road, and increasingly better-looking cars.

At the same time, consumers are being led toward new expectations—new kinds of unmet needs—by the most disruptive innovators, many from outside the traditional auto ecosystem. When Uber shows them they can have a car available to them on demand, when and where they want it; when the iPhone teaches them they can have a beautiful, stylish piece of equipment that satisfies their desires for music, the Internet and phone service in one device, they learn of something they "always wanted." Now, courtesy of disruptive innovations, they demand it.

Most recently, consumers have learned to expect a new kind of satisfaction from their cars–a "new sense of good." It's the kind of good they feel when their tablets or smartphones upgrade during the ownership cycle; the kind of good they experience with customer service that is high-touch and rewarding; and the same kind of good they associate with dazzling new technology.

The Robust Industrial Machine and the Sexy Dynamic Experience

Because consumers expect both a safe, reliable, fault-tolerant car and a new sense of good, they bring on the extraordinarily different clockspeeds car companies must now satisfy.

The more familiar expectations require innovations intended for scaled metal bending and assembly, geared toward what we call the "Robust Industrial Machine." The Robust Industrial Machine requires a 5–7 year clockspeed for powertrains, vehicle platforms, and other essential mechanical elements to provide a reasonable return on investment.

The power of the Sexy Dynamic Experience should not be underestimated; sexy can kill robust

The other expectations respond to a new competitive landscape, where technology innovation and payback periods are more like those found with consumer electronics, software, and communications. Those expectations drive not one but multiple clockspeeds for innovation that are faster than the traditional one—and we predict they will get far, far faster because of the accelerating pace of technology innovation. The speedier paces of innovation come out of consumer demand for what we call the "sexy, dynamic experience". The characteristics of the Sexy Dynamic Experience are already familiar ones in the market:

- Products repeatedly evolve and improve after purchase.
- Products are flexible, able to create environments or experience that is configurable with a consumer's tastes or usage situation. This desire for flexibility goes way beyond station pre-sets. Imagine a sedate, well-damped, autonomous rolling office by day that transforms into a responsive, raging drift machine by night.
- New enhancements are reverse compatible. They not only improve performance but work with earlier platforms.

The power of the Sexy Dynamic Experience to drive innovation and to change markets should not be underestimated: sexy can kill robust. In 2006, both Nokia and Blackberry competed as Robust Industrial Machines. They offered as their chief selling points superior battery life, slim size, excellent call quality and strong security. Along came the iPhone. Viewed according to the dimensions by which Nokia and Blackberry competed, the iPhone was nowhere near as strong. It didn't matter. The iPhone offered apps and content—music and video. It was cool, configurable, and regularly updated. It blew away the competition. The Robust Industrial Machine lost out to the Sexy Dynamic Experience of a phone that was no longer a phone, radically re-drawing the nature of competition.

Image provided courtesy of Peugeot

Changing consumer behavior and a transforming competitive landscape

Image provided courtesy of Mercedes-Benz

The Sexy Dynamic Experience is not simply for smartphones. The auto industry now faces it in multiple areas. Changes in consumer behavior and changes in the competitive balance are together accelerating the pace of innovation in the auto industry, especially in the key areas of mobility-on-demand, autonomous vehicles, and connectivity.

In each of these spaces, an accelerated pace of innovation is occurring at different rates, forcing the auto industry to address a number of faster clockspeeds, from affordable upgrading of sensors, actuators, and displays in 18 to 36 months to quarterly over-the-air upgrades of software.

Consumers want one trillion miles of more mobility

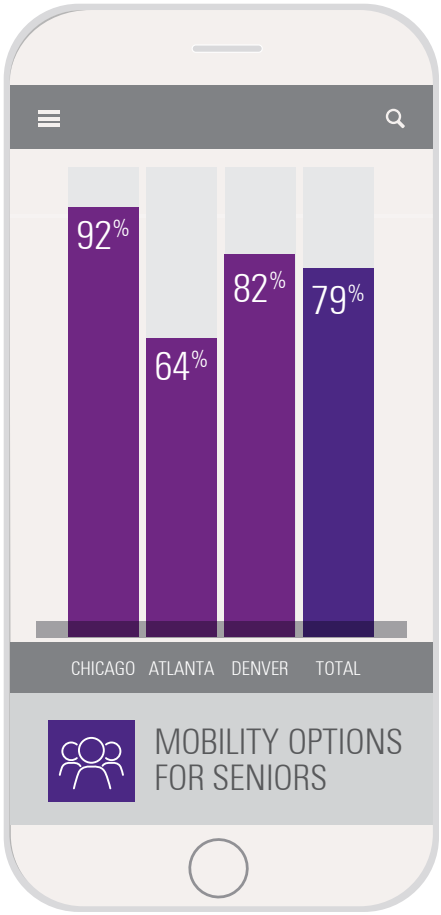
In previous papers, we described how innovations in autonomous vehicles, connectivity, and mobility-on-demand are affecting consumer behavior and creating new unmet consumer needs. We haven't changed our perspective. Those innovations are producing changes in consumer behavior that lead them toward the Sexy Dynamic Experience, creating the faster clockspeeds that the auto industry must satisfy—especially when it comes to mobility options.

One thing is different, however: We are floored by how much the pace of change has accelerated in just one year. When we look at focus groups and our modeling, we understand why.

Two roads to the same place: An increasing desire for mobility options

Two generations will largely drive consumer demand in the future, the millennials and the "baby boomers plus"—those ranging in age from 45 to 75 years. Both groups are changing their behaviors but in wildly different ways. The boomers are moving into cities and holding onto their cars, at least for now. Millennials' income and debt levels restrict their buying power and reduce their brand loyalty. The boomers and millennials share one interest, however: They already like mobility-on-demand services. We think their like is going to turn into love.

Focus group results



OVERALL, 79% OF PEOPLE ASKED IN FOCUS GROUPS WOULD WANT MOBILITY OPTIONS FOR SENIORS

79%

Source KPMG focus groups and analysis

The 45-to-75-year-olds

Among the boomers plus, people are living longer, delaying retirement, and moving to cities. Sixty-five is the new 45. In this demographic, many are still working in their sixties because they are healthier than past generations.

Older boomers, however, have concerns about the safety of their driving as they age. So do their children. They are not going to stop being active, however. Some of them will continue to work well beyond the typical retirement age, all the while traveling on the weekends. Some will slow down but still join their friends and families for weekly activities, whether card games, concerts, sports events, or the activities of their children and grandchildren. Others may do far less, but over the next decade, the 45–75 year olds will still be healthier than in the past and more tech savvy. They won't be intimidated by mobility options.

65 is the new 45.

Focus group participants: Aging/Parents

Ron, 67 (Denver)

"I happen to live in a retirement community. There's an awful lot of people there who shouldn't be driving."

Lenny, 71 (Denver)

"My mother had dementia for years. She'd have loved this because she would have loved me not showing up all the time telling her what to do."

Mary Anne, 37 (Atlanta)

"My dad is in his early 80s. We have had problems. We actually moved him from San Diego to here a year ago. None of us can get in a car with him. We all get sick. He's hit stop signs. He killed a tree. He will not stop driving. It's nerve-wracking. Mobility-on-demand would be perfect."

Antoinette, 53 (Atlanta)

"Both my parents have Parkinson's. My dad does not drive at all. My mom does not drive at night anymore. Mother is very active. She plays bridge all over the city. She'll come visit me. Her driving is always an issue. This would be great."

Lesley, 56 (Chicago)

"The auto parts store used to keep sideview mirrors for Mom's car in stock because she knocked them off all the time. I'd walk in, and the guy at the auto parts store would tell me, 'by the way, we have three extra mirrors for you.'"

"I don't have to take the keys away from my dad."

About our focus groups

KPMG held focus groups in three locations: Denver, Colorado; Chicago, Illinois; and Atlanta, Georgia. We selected the locations to achieve both geographic and cultural diversity. Denver is an up-and-coming millennial city with relatively little in the way of public transportation and higher vehicle ownership. Chicago has a clearer center of gravity and is far better served by public transportation. It is possible to live in Chicago without owning a car although a majority of residents do, in fact, own a vehicle. Atlanta, Georgia is a large city with relatively little in the way of public transportation, a high vehicle ownership and attachment to vehicles, and high commute times. Participants in our focus group were at least 18 years of age. All had completed some college or vocational school. All had family incomes over $25,000 per year.

We have changed the images of our participants to protect their privacy.

Their almost-instant attraction to mobility services comes from a common concern they voiced in our focus groups from Atlanta to Chicago to Denver—sometimes in virtually the same language: With mobility services, "I don't have to worry about taking the keys away from my dad, and I don't have to worry about his driving."

The 80 million-plus millennials have grown up able to use technology easily and trusting in it.

The 10-to-15-year-olds

Children and the parents of children share the boomers' interest in mobility-on-demand services but for different reasons. For the children, it's all about freedom, the ability to meet up with friends, or go to movies, soccer games, softball, music lessons, or countless other activities without having to get their parents or someone else to drive. Relying on Uber? Via? Lyft? An autonomous vehicle in the future? No problem. They've grown up not only tech savvy but instinctively trusting in technology. Once they know of mobility options, they'll leap to use them.

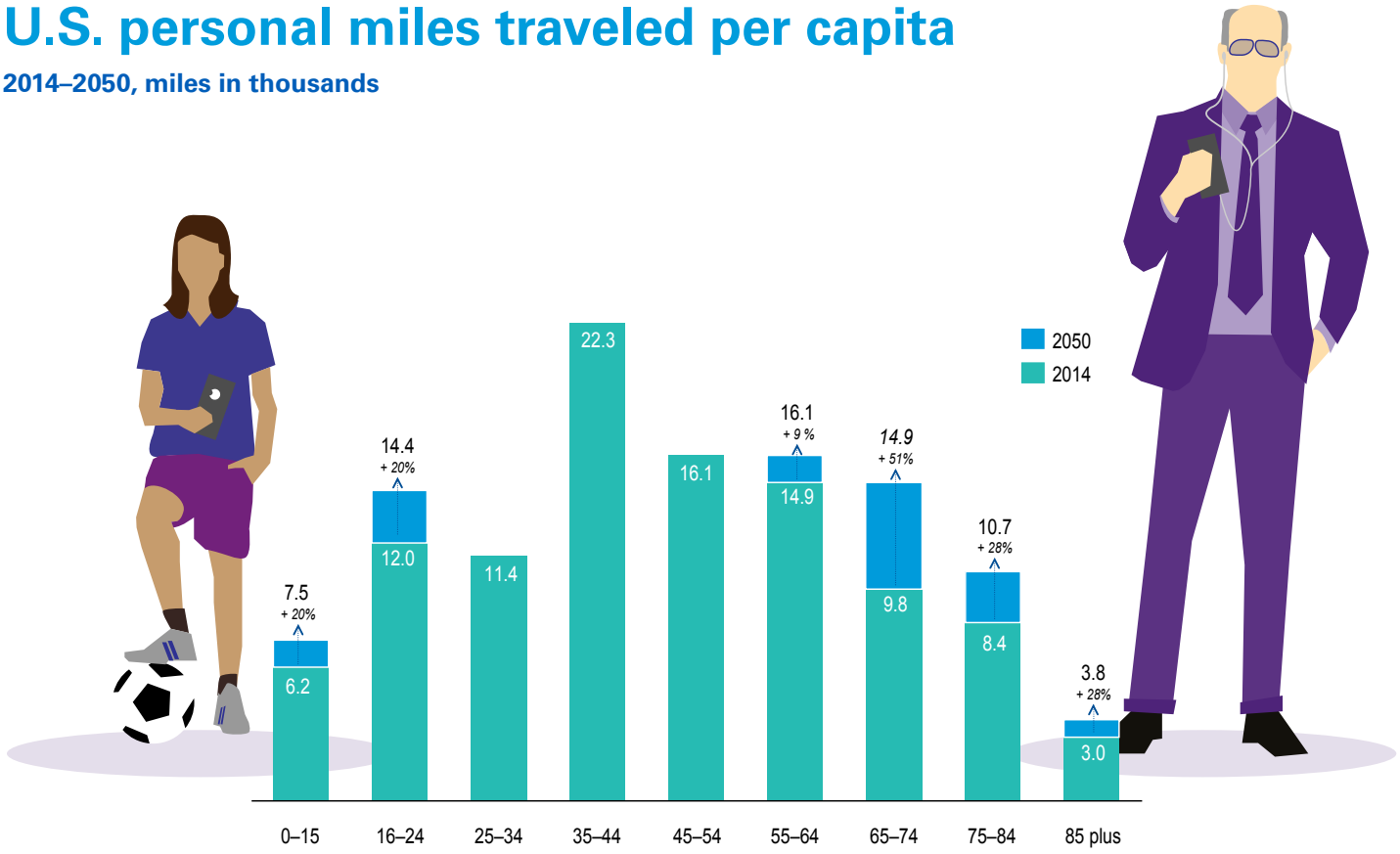
In fact, the only limitation on their use of mobility-on-demand services will be their parents, who are not about to put a six-year-old in a Lyft or Uber vehicle.

Then again, once their children are a little older, parents are likely to show strong attraction to mobility options. We observed pronounced interest in our focus groups. It sounded something like, "I'm no longer the taxi driver. I get to recapture my life. I have more free time."

Here, too, our predictions could be understating parents' attraction to mobility-on-demand for their children. Mobility-on-demand will be especially attractive for parents in the future. When they have children, they will hesitate less than their parents to use mobility-on-demand services.

U.S. personal miles traveled per capita

2014–2050, miles in thousands



Note: (a) Discounted 25% from U.S. BTS total VMT for 1995, 2001, 2009, 2014 (assumed to be commercial miles), (b) Multiplied by NHTS occupancy rates applied 2009 rate to 2014 numbers). Source: US BTS data, NHTS data, U.S. Census data, KPMG Analysis

"Parents can be everywhere at the same time."

Focus group participants: Children

Arlene, 74 (Denver)

"For high-school-age kids, it might be a good thing because kids do crazy things, and I'm not sure we're always available to pick them up. I'd be happy to pay a mobility-on-demand service rather than see them getting in a car with someone I didn't know who might be drinking."

Michelle, 38 (Atlanta)

"I have three children. My 16-year-old got a job. It was a nightmare. I felt like I was a taxi. I felt like she should be paying me for driving her around all the time. I don't want to go out in my pajamas at 11 o'clock at night to get her."

Antoinette, 53 (Atlanta)

"When they get to that age, their social lives interfere with my social life. To have mobility-on-demand as an option is great."

Mary Anne, 37 (Atlanta)

"I have little ones, and when I think about the daily driving, it scares me. I'm getting sold on the whole mobility thing. I'm excited now to use it."

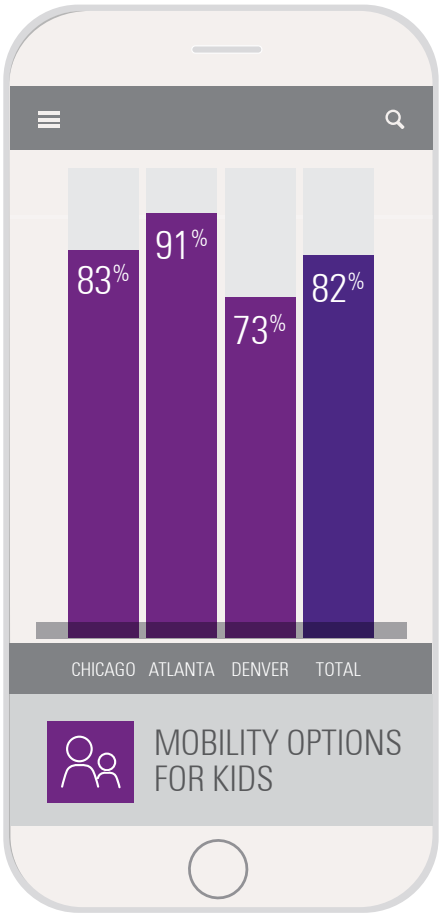
Nancy, 37 (Chicago)

"I'd be comfortable sending an eight-year-old in a mobility option. I was traveling on the train going to grandma's house by myself at that age."

Lesley, 56 (Chicago)

"I'd be comfortable with a six-year old, so long as they know what the address is and can say their name and know what's going on. Kids are so smart these days. They're using computers at five. The kids in my computer class in kindergarten, first, and second grade are sometimes far better with computers than my eighth graders."

Focus group results



OVERALL, 82% OF PEOPLE ASKED IN FOCUS GROUPS WOULD WANT MOBILITY OPTIONS FOR KIDS

82%

Source: KPMG focus groups and analysis

A trillion-mile surge

These changes in consumer behavior seem modest, but small changes in personal travel choices can have a big impact in the future… and personal miles traveled (PMT) will soar! As we reported, our focus groups indicate that the oldest and youngest age groups have an increased interest in mobility-on-demand services. Based on current consumer perceptions, we would have expected only small effects from their increasing use of mobility options.

Our modeling tells us something far more exciting. It turns out that these small changes among the oldest and youngest demographic groups will likely produce large increases in personal miles traveled (PMT) by 2050: approximately 500 billion more PMT annually. Once we factor in population growth, that increase in personal miles soars to nearly one trillion additional miles per year.

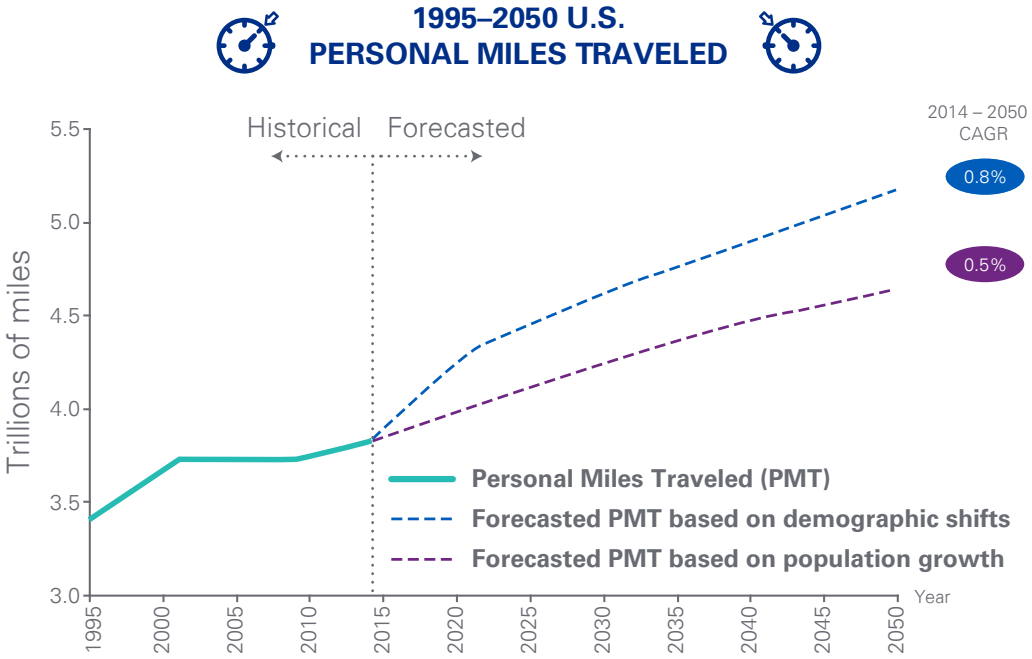
When we first calculated these figures, we were astonished. Then we looked at our assumptions and realized that the number is likely to be far larger. Our figures reflect only the United States, but the increasing demand for mobility options will be global. Japan's more aged population will produce even greater need for mobility services for its seniors. China's population, aging as a result of the one-child policy, represents a mind-boggling demand for mobility services only 20 years later than the United States.

The increase in personal miles traveled may seem startling, but think of it this way: 10 years ago, how many of us would have predicted that most 10-year-olds would be walking around with smartphones? We grossly underestimated that trend. If we don't watch out, we'll grossly underestimate the power of these changes in consumer behavior around mobility options.

One thing is for sure.

Those additional personal miles traveled offer a golden opportunity for the auto industry. They represent an additional trillion miles of new mobility options and the potential for new business models to satisfy them. This then increases the pressure for powerful, strategic innovations to satisfy customer demand.

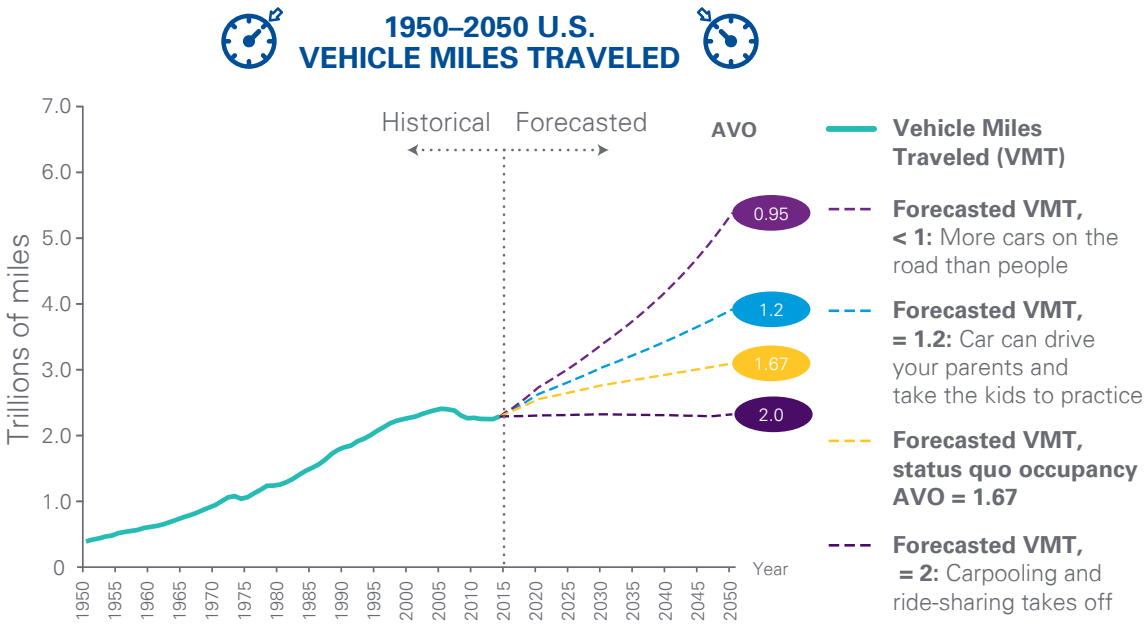
Small changes in the travel preferences by different age groups results in large changes in total personal miles traveled.



Note: (a) Discounted 25% from U.S. BTS total VMT for 1995, 2001, 2009, 2014 (assumed to be commercial miles), (b) Multiplied by NHTS occupancy rates applied 2009 rate to 2014 numbers.

Source: U.S. BTS data, NHTS data, U.S. Census data, KPMG Analysis

Large increases in personal miles traveled can ripple into a trillion more vehicle miles traveled.



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Source: U.S. BTS data, NHTS data, U.S. Census data, KPMG Analysis

Impact to vehicle miles

But we didn't stop there because as it turns out, large increases in personal miles traveled can ripple into even larger fluctuations in vehicle miles traveled (VMT). As younger and older age groups are making small changes in their mobility decisions, the choices they make affect the number of average occupants in each vehicle.

At current occupancy rates, if the status quo were maintained then we'd see an over-trillion-mile surge in VMT. But, if those occupancy rates were to change—for example, if more younger or older age groups started to select new self-driving options—then we could see twice as much demand. And if we moved into a scenario where there are more people than cars on the road and occupancy rates fell below one person per car—for example, many self-driving cars without passengers—then the increase could be as large as three to four trillion additional miles. That is a staggering number, but one that is not outside the realm of possibility by 2050.

While not all of those miles necessarily translate into additional cars on the road, it does have the potential to change trip frequency, vehicle utilization, and ownership models. Furthermore, those increases will likely have a profound but unknown impact on vehicle sales, car ownership models, energy demand, and infrastructure. So much so that we believe that differences in the desired mobility experience may drive new tailored missions with enough underlying demand to influence the car sales down the road to meet those needs.

More factors pointing to spiking interest in mobility-on-demand

Our focus groups provide evidence of even greater consumer demand for mobility options than we are projecting. In every age group, focus group participants showed significant attraction to mobility on demand for specific conditions or circumstances, including safety, weather, premium experience, and leisure time.

Safety

Drivers of all ages showed an immediate attraction for going to and from areas they do not know or pose some risk to their security. A concert that ends late at night, a more desolate stretch of a city, a late night at work—mobility-on-demand was definitely more desirable than walking by themselves to their cars or standing on a street waiting for a taxi.

Sharon, 42 (Denver)

"I don't like to take public transit after about 9:30 or 10:00 at night. As a woman traveling alone I think you have to be mindful of your safety."

Caroline, 55 (Atlanta)

"I stay late at work sometimes for presentation. I often worry about being sleepy as I drive home. That's the first thing that comes to my mind when I think about why I'd use it."

Antoinette, 53 (Atlanta)

"I have a lot of girlfriends, and we'll meet for dinner and stay out late. So then five ladies have to split up and go on parking decks at night to get their cars? Mobility-on-demand would make us feel a lot safer."

Mason, 69 (Atlanta)

"Most of the time I come into the airport late at night, I take Uber. It's safer and quicker then."

Weather

A blizzard, ice on the roads, a thunderstorm, extreme cold or heat—every one, male and female, opted more often for mobility-on-demand.

Curtis, 63 (Atlanta)

"I'll let somebody else have the headache when the weather is bad. I just want to look out the window."

Jeff, 60 (Chicago)

"I was coming back from St. Maarten. It was about 75 there and 10 below here, so yes to mobility on demand."

Premium experience

The future of mobility-on-demand might include specialization: different solutions for millennials and baby boomers that may include a more mission-specific sense of premium mobility options.

Nicole, 26 (Atlanta)

"We used Uber for an outing for work. They wanted us to have a limousine-type experience."

Mason, 69 (Atlanta)

"I know someone who had a cell phone slip out of his pocket. Uber called him within probably 20 minutes to tell him they had his cell phone. They put it in another Uber and brought it to him at no charge. In a taxi cab, he might never have seen it again."

Leisure time

For all age groups we explored, focus group participants liked mobility options for when they went out on the town. They like the idea they don't have to worry about driving, especially after having a few drinks, and they distinctly associated mobility options with pleasure and time for themselves. We can only imagine what will happen as mobility-on-demand becomes less of a treat and more of a habit.

Alcohol

Nancy, 37 (Chicago)

"We use it all time when we know we're both going to be drinking. It's a hell of a lot cheaper than DUIs."

Eddie, 30 (Denver)

"If I am drinking at all, I'd prefer, to factor that out as a worry."

Sporting event/Concert

Max, 64 (Denver)

"You know, for a concert or a sporting event, like if I'm going to Red Rocks, I would take one. Who wants to be screwing around with parking during a Broncos game?"

Emily, 36 (Chicago)

"We took it to a concert at Allstate because trying to get out of there afterwards and parking beforehand is a nightmare. My husband, he's a firefighter, so obviously drinking and driving is nothing he's going to do, but… it reduces the stress."

Competitors are innovating at Sexy Dynamic clockspeed

In previous papers, we described how the automotive ecosystem is undergoing significant transformation from the introduction of autonomous vehicles and from changes in connectivity and mobility-on-demand. The innovations in these technologies are driven by changes in customer behavior, which are bringing in competitors from fast-paced industries: tech giants, high-tech start-ups, and companies in telecom and consumer electronics.

These players are disrupting the auto ecosystem. For the first time, the auto industry faces competitors who are used to responding to far greater numbers of consumers and operating with hundreds of millions of units rather than the millions with which automakers work. That larger economy of scale gives them the potential for quick and impressive payback, and it enables them to achieve a faster pace of innovation. Now they are advancing on the auto market with its one billion cars on the road.

Some of them will compete by directly appealing to Sexy Dynamic Experience. To their mind, the car is less a Robust Industrial Machine than it is a computer on wheels. Asked about its rumored interest in the car market, Apple Senior Vice President of Operations Jeff Williams commented:

"The car is the ultimate mobile device, isn't it?"

However they make their appeal, they will bring innovation quickly, and as consumers encounter their innovations, they will ask for still more of them, compounding the pace of technology change the auto industry must then meet.

Acceleration in mobility services

The watchword is "acceleration"—accelerating innovation and accelerating competition. In our last paper, we described a revolution in mobility services. Just the same, we didn't realize how big a revolution it was or how fast it was coming. Mobility businesses have exploded across the globe, bringing with them transformations in what we call "moving me, moving my stuff, and moving my car." The influence of these changes on the car industry is as yet unknown, but there are significant reasons why industry players must pay careful attention. The potential effects might include significant increases in vehicle miles traveled. If so, that would certainly change the kind of cars sold, which would in turn affect car ownership models and car and truck sales—in as yet unclear ways.

Image provided courtesy of NVIDIA

"Moving me" started the explosion, a global phenomenon of mobility-on-demand.

Alongside of taxicab and traditional car rental services, we now have Uber, Lyft, Didi Kuaidi, Zipcar, Halo, and more. Bla Bla Car's ride-sharing business moves Europeans from city to city in 19 countries. Moving people disrupts far more than traditional taxi and limousine services, however. In San Francisco, Uber has grown its revenue by more than $1 billion in five years, expanding a market and competing with not only taxi services but car rental agencies, parking lot owners, and vehicle replacement businesses.

Just as explosively, these innovators have extended themselves into other businesses: "moving my stuff."

It used to be that delivery was a matter for traditional truck and bicycle services. The new players in mobility-on-demand are creating collateral businesses that threaten to disrupt the traditional competition. Audi, Amazon, and DHL have teamed to deliver belongings to the trunks of consumers' cars. Instacart is delivering groceries to consumers' doors within an hour of ordering them. Even UPS and FedEx may face serious competition in the future. Amazon is experimenting with drone delivery—seemingly laughable now, but look out if they get the cost down. For the auto industry, the effect is still uncertain, but the potential for reducing sales on delivery vehicles is nothing to dismiss.

And the mobility innovators aren't stopping with delivery but extending services to "moving my car."

RelayRides is building a market for renting out consumers' idle vehicles. Valet services were once for rich people. Now Zirx acts like a virtual valet, parking and moving consumers' cars as well as servicing them. Imagine the ability of consumers via an app to have someone show up at their door or their workplace and take their car for them. They no longer have to worry about parking. "Moving my car" innovations can easily lead to new unmet consumer needs, such as still more car-sharing that drives down car sales or changes their utilization.

The implications of mobility competition

We predict still more effects from the changing competition in mobility: more competition, more consumer adoption, more disruption, greater controversy, and, above all, a faster pace of innovation.

The genie is out of its technological bottle: Things will only go faster. Innovators are making their presence known, and consumers are quickly recognizing they like this new flexibility and availability in their transportation options.

- No doubt the intensity of competition will mean pricing will remain highly competitive. It will also spawn still more innovation: In response to Uber, New York City's taxi services just announced their own taxi-hailing app, Halloo.
- With disruptions come political controversies. In New York, consumer demand for mobility-on-demand cowed the mayor. When His Honor tried to restrict Uber services, consumer uproar made him retreat. Whatever the controversy, we believe the free market will ultimately prevail.

We expect consumers are going to move from making marginal decisions to use mobility options—an occasional ride here or there—to utilizing mobility-on-demand consistently. Where mobility options have begun to flourish, the two-car model is cracking.

New competitors in autonomy will power a still more accelerated pace for autonomous vehicles

Acceleration in autonomy

Those mobility-on-demand innovators also want to be autonomous: Uber recently announced it would buy self-driving cars from Tesla when they become available. Uber's ambition, however, is just the tip of the iceberg. Under the surface is a far-reaching commitment to autonomy innovations from players outside the auto industry who have enormous resources and the freedom to build autonomous vehicles without the platform constraints of OEMs. They are forcing an accelerated pace of change.

Of course, the auto industry has accelerated the pace of innovation on its own. In 2005, after more than 25 years of research, five Level 4 autonomous vehicles successfully completed the Great Challenge, a 150-mile course through the Mojave Desert. Flash forward 10 years: Ford has patented an autonomous car with reconfigurable seats. Continental is testing three highly autonomous vehicles. Mercedes Benz previewed a fully autonomous car at the 2015 car show, and Volvo will begin a trial of 100 self-driving cars in 2017. Partial autonomy developments have also accelerated since 2000, and the commercial infrastructure of the industry is developing. Examples of it include Ford's autonomous vehicle program, GM and Carnegie Mellon's Autonomous Driving Collaboration Research Lab, Volkswagen and Stanford's VAIL program, and Toyota's recent investment in autonomy. That is extraordinary progress.

But new competitors are rushing into the autonomy space, and they don't have to contend with existing infrastructure—billions of dollars in fixed assets—as traditional automakers do. Freed of those platform constraints, these new players are moving fast. Since 2009, Google's self-driving cars have logged 1.7 million miles. Apple announced its Apple Car will appear in 2019. Meanwhile, in partial autonomy, Tesla's latest OTA update provides highway autopilot—no need for drivers to touch the brake, accelerator, or steering wheel when they are on freeways. And in commercial infrastructure, there's Google's Self-Driving Car Program and even Uber's investment in autonomous research at the University of Arizona.

The arrival of new, aspiring automakers is not the only development of consequence for the auto industry. There are at least 17 companies outside the traditional ecosystem who have announced plans to invest and contribute research and products to support autonomous systems. Some are accomplished start-ups. Cruise Automation has already passed significant milestones in delivering technology that will enable cars to drive themselves. Whatever their offerings will be, these companies will significantly accelerate the knowledge base for autonomy.

Collectively, these new entrants into the auto ecosystem are making substantial financial commitments to autonomy.

The net result is clear: The efforts of these new competitors in autonomy will power a still more accelerated pace for autonomous vehicles, far faster than the pace at which the traditional auto industry has been operating.

The implications of changing competition in autonomy

As the nontraditional competitors continue to surge into the autonomy space, we predict they will do more than push the speed of technological change the auto industry must follow. They will also upend after-markets and related markets. Once consumers see that autonomy makes people safer and drives down the cost of insurance and repairs, their demands will create further pressure to accelerate the rate of autonomous innovation.

More new innovators in autonomy are entering the ecosystem, disrupting the traditional supply chain. Mobileye and VocalZoom aren't Tier 1s or OEMs but nontraditional sources now active in the auto space.

New geographic centers for autonomous innovation have emerged in locations ranging from Silicon Valley to Tel Aviv. In sum, developments in autonomous vehicles may appear in any number of locations worldwide.

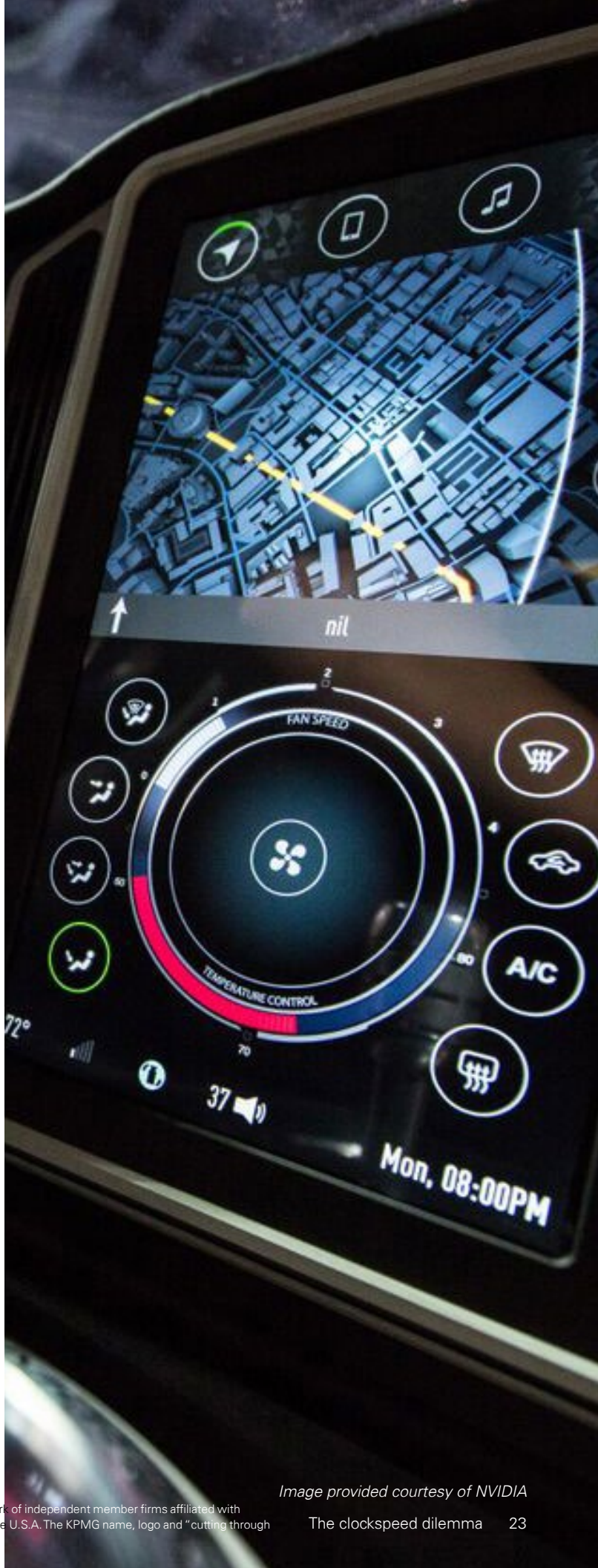


Image provided courtesy of NVIDIA

Acceleration in connectivity

The technological changes in autonomy have led to new and extraordinarily resourceful players in connectivity, competitors who are forcing an accelerated pace of innovation for connected vehicles.

Predictable innovations

Over time, we expect to see fleets of connected vehicles working with telecom and wireless companies to create a comprehensive infrastructure—one that supports the anticipated demand for consumer access, navigational accuracy, and the immense amounts of data required to be streamed to and from every vehicle.

We expect to see fleets of connected vehicles working with telecom and wireless companies.

Cars will connect with the infrastructure and stream telematics information about traffic, road conditions, and lane speeds. Vehicles will constantly self-identify, monitor the surrounding environment for hazards and potential threats, and adjust navigation and guidance to address those dangers. Automakers will collect data to monitor the individual status of a car or to fix problems in a particular model preemptively.

Passengers will be able to access streaming data feeds for entertainment and to utilize their handheld devices for on-the-move data streaming. They will also use their cell phones to locate their cars, turn them on, or assess their repair status. These innovations will, of course, greatly improve the driving experience of the consumer, produce greater safety, and increase longevity for the car.

Together these innovations will dramatically enhance connectivity between the car and external networks; connectivity that passengers use for entertainment and communication; connectivity between the car's internal systems; and security for all connectivity. Each of these changes will require high-speed ubiquity in the communications environment.

Enter the new players

These predictable innovations are only the beginning of changes in connectivity because of what this new communications environment attracts. Many aggressive players are now entering the connectivity space. A short list includes not only makers of chips, pipes, receivers, and software, but also data aggregators and content providers. The sheer number and power of these players will drive phenomenal, fast-paced innovation that could arrive in cars at any time. Since many of these innovations may not come from the auto industry, automakers will need to work closely with those driving changes.

Economies of scale and changing competitive advantage

Automakers will be facing players whose economy of scale and investment capacity is significantly higher than theirs. The Apples and Googles of the world produce hundreds of millions of units rather than the millions of units the car industry manufactures. According to Gartner, global smartphone manufacturers sold 1.245 billion units in 2014. That same year, the auto industry sold 87 million cars.

These big players in the connectivity space can amortize their research and development budgets over a far larger base than automakers can. They are also free to spend more than car manufacturers, who must devote considerable R&D dollars to maintaining the Robust Industrial Machine.

Embedded connectivity versus hybrid and nomadic devices: Vigilance required

That advantage in scale is especially important since the auto industry's embedded devices must compete against hybrid and nomadic ones. It makes decisions especially difficult, requiring great awareness of changes in the ecosystem and an ability to respond flexibly and fast.

Of course the connected car has some elements that are better served by embedded technology, especially telematics and vehicle configuration. For other connectivity elements, however, the industry must pay careful attention or risk losing a competitive advantage. Hybrid and nomadic devices are more readily innovated and more able to respond to consumer expectations nimbly.

With three different kinds of connectivity devices undergoing innovation, there is also greater possibility that consumers' unmet needs may increase and change in a number of unpredictable directions. One effect this may have will be diversifying the idea of premium performance based on demographics, as we suspect may happen in mobility-on-demand. Airlines already sense this change and are debating whether they should provide embedded entertainment devices or set-ups to which consumers' devices tether—hybrids. Consumer demand may well drive them and the auto industry in a few directions. Targeted, mission-specific performance may be the wave of the future in connectivity.

Uncertainty abounds

As the pace of connectivity innovation grows faster and more diverse, the winners become more unpredictable. Just who will the major forces in connectivity be? Who will increase in influence or disrupt? The traditional tech giants are playing in this space, but their innovations may not come to dominate. Powerful players in the connectivity space could arise anywhere, from those advancing facial recognition software to those involved in cognitive computing:

- **Big players have big plans for the space**, which will certainly impact consumer expectations for connectivity. Apple's Carplay will allow a number of apps to be used in the car, from Siri to iTunes, while Google's Android Auto will provide a similar assortment of apps, messaging, music, and voice-activated commands.
- **Explosive growth in digitized information**, dramatic development in facial and voice recognition capability, exciting progress in quantum computing—these are signs of tremendous technological advances that may mean Apple and Google will not be the ones who dominate.

A final prediction: The end of an era

As a result of this changing competitive landscape, we fully believe that in 10 years, many of the major automakers will no longer be around, at least not as independent companies. Those who survive must be able to meet the faster clockspeeds of the Sexy Dynamic Experience while staying true to the pace necessary for producing a Robust Industrial Machine.

How to solve the clockspeed dilemma

So what should an automaker do? How does it innovate facing the clockspeed dilemma?

This will be hard. Yet innovating successfully will be the difference between winners and losers in the evolving industry.

We believe the solution requires two essential and related steps:

Step 1: Facing the obstacles to change

Step 2: Aligning the organization for fast-paced innovation

The power of a solution lies in its details…

Facing the obstacles

Most traditional automotive players nod in recognition of multiple challenges but have not fully come to terms with their effect on the ability to innovate. They understand completely that fast-paced innovation can be disruptive, and they understandably struggle to balance it with core businesses they must not change. And yet there are other cultural and institutional obstacles—many of them core strengths in the past—that impede innovation in the current ecosystem:

Securing new talent

The industry is losing the war for young talent at the same time its knowledge base is shrinking as older talent retires. For many reasons, traditional automotive companies aren't places where the most talented millennials dream of working.

Rewarding failure

Innovation is high risk and requires failure—something that true innovators expect and celebrate—but the industry tends to reward well executed, low-risk change.

Investing in risk

Innovation means making financial commitments according to compelling investment theses. The traditional industry makes business decisions based on carefully calculated ROI. As a business decision, it would have turned aside Uber.

Thinking disruptively

The traditional industry often finds it difficult to embrace truly powerful innovation, refusing to examine it where the industry has been most successful. That's different from the courage Apple showed to intentionally disrupt the iPod with the iPhone, producing a phenomenal result.

Partnering to innovate

With a heritage of engineering success, the industry instinctively prefers to build from within, cutting themselves off from the ideas of outsiders and the dynamism partnerships bring.

Building global awareness of innovation

The industry needs to capitalize on innovation anywhere, which means it needs better awareness of new centers of innovation everywhere from Tel Aviv to Berlin and from New York to Silicon Valley.

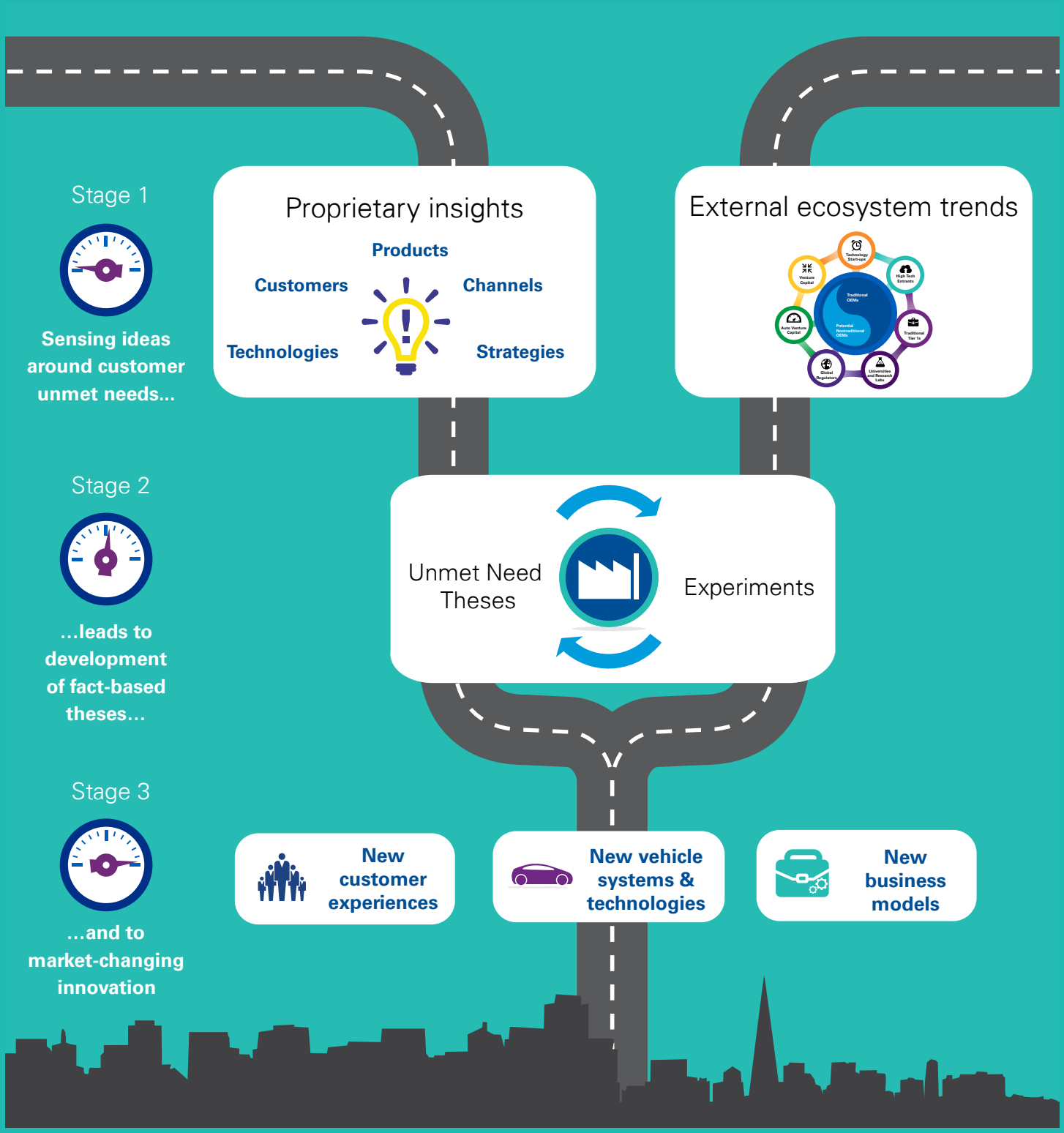
A framework for innovation

There is a means of addressing these challenges and achieving faster-paced innovation. First, however, a simple truth: There's no single answer to innovating successfully, no one-size-fits-all solution. No expert—no business professor, successful entrepreneur, author, or consultant—offers a prescription that works for every company and every situation. The most successful innovators today take different approaches. And successful innovators from the past don't offer an enduring lesson for all circumstances and all companies.

Of course, we have seen and believe in patterns and common elements to some solutions, but successful innovation fits the individual company and its culture. It must be customized. It must be bespoke.

Building a bespoke innovation engine

Solutions for consumers' unmet needs can be explored based on establishing unmet need theses for experimentation



A bespoke solution works like an innovation engine with a three-stage assembly line: sensing unmet needs of the consumer from a profound awareness of the auto ecosystem and a leveraging of the proprietary insights of the company, intensively investigating potential innovations from these insights; and creating market-changing innovations that are appropriate to the culture of the company. It's a complex process that we can only sketch here, but the result of it is that a company can institutionalize faster innovation paces.

Stage 1

Sensing consumer unmet needs: Awareness of the ecosystem and proprietary insights

Successful, faster-paced innovation is built out of the capacity to anticipate the unmet needs of consumers. Most businesses can sense the current needs; it's the unmet needs that are more difficult to see. The ability to discover unmet needs develops only when a company is finely tuned to what is happening in the auto ecosystem—in as broad and careful a way possible—and when it leverages its own proprietary insights.

Stage 2

Developing innovations: From unmet need theses to experiments

In the second stage, the innovation engine carefully evaluates the unmet needs it senses and creates a select number of unmet needs theses. An unmet need thesis is the result of intensive investigation: The engine makes certain that a promising unmet need is absolutely the result of clear, fact-based proprietary insights and a clear sense of the ecosystem. It then rigorously evaluates what it senses and chooses what has the best potential.

Just as important, the engine does not settle on a single unmet need thesis but multiple ones—unmet needs theses. It never places all its bets in one area of consumer unmet needs alone.

The engine pursues the potential of each unmet need thesis fiercely. There is no fear of failure. It explores the thesis in multiple internal and external experiments, and it evaluates the results of each experiment quickly, thoroughly, and dynamically:

- Every experiment provides data that might lead to a new thesis about an unmet need and a new experiment in how the company might innovate around it. There are no simple successes or failures.
- An experiment that doesn't work is quickly ended—ruthlessly, some might say. But its results have valuable information leading to new ideas, and it may also have successful elements that are culled and combined with other experiments.
- Successful or failed experiments may lead to still greater success when synthesized with other ideas.

Stage 3

Leading to market-changing innovations specific to the company

In turn this leads to market-changing innovations. The innovation engine can produce changes in many forms, including innovations in consumer experience, technologies or vehicle systems, and business models. All fit the company, which the lens of proprietary insights and the testing of investment theses ensure.

Solving the clockspeed dilemma: Integration

With this new capacity for fast innovation in place, one last and important step remains. The multiple clockspeeds of faster innovation must then connect with the larger organization of the company. They must be integrated with existing processes that connect the company with its customers. It is a simple, elegant, and individual solution to solving the clockspeed dilemma, but it is still hard to do.

Conclusion

Setting the pace

We're riding a wave of fantastic innovation that's going to be still more fantastic and happen faster and faster. It may seem daunting, but the traditional auto companies can institutionalize a faster-paced innovation capacity to go with their current one, as the innovation engine suggests. If they do and if they integrate their innovations with their larger organizations, they will be able to meet the variety of clockspeeds that this new normal asks of them. They'll embrace the relativity of time. It is an exciting, powerful era. The right approach will lead a company toward a powerful future, a winner.

Who will be among the next generation of leading companies?

What new business models will emerge?

How bold will your company be?

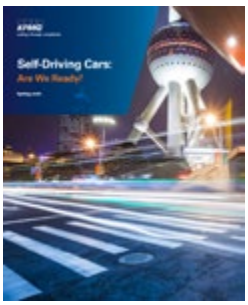
KPMG Automotive practice

In case you missed them, you can download our previous papers related to the future of the automotive industry.

Self-driving cars: The next revolution

August 2012

For the past hundred years, innovation within the automotive sector has brought major but mostly evolutionary technological advances. Now, the industry is on the cusp of revolutionary change with the advent of autonomous or "self-driving" vehicles. KPMG LLP and the Center for Automotive Research (CAR) joins forces in examining the forces of change, the current and emerging technologies, the path to bring these innovations to market, the likelihood that they will achieve wide adoption from consumers, and their potential impact on the automotive ecosystem.



Self-driving cars: Are we ready?

October 2013

Gaze out at the automotive horizon and you can almost see a new era coming into focus: the age of self-driving cars. Ultimately, the shape of the automotive future will depend on consumers—their needs, preferences, fears—and their pocketbooks. Will they trust these new vehicles? What will future car buyers care about? If we build self-driving cars, will they come? KPMG seeks to answer these questions through the lens of real consumers who provide us with their unique perspective on the self-driving market.

Me, my car, my life

November 2014

Not since the first automotive revolution has there been such stunning innovation in the industry. The convergence of consumer and automotive technologies and the rise of mobility services are transforming the automotive industry and the way we live our lives. How will the automotive industry adapt to this new world? How is technology reshaping the automotive ecosystem – and how will these industries work together? What will customers of the future expect from this collaboration – and be willing to pay for?

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