THE **STATE** OF

AUTOMOTIVE

by Victor Kingery

2016 REVIEW + **2017** OUTLOOK

EXECUTIVE SUMMARY

The automotive industry has arrived at a major inflection point, signaling a period of intense change and the evolution of the entire industry. What has been traditionally thought of as “automotive” will over the next few years come to be known more broadly as the “mobility industry”—the next generation of products and services enabling the transportation of people and goods. These products and services include traditional products such as cars, trucks, buses, trains, airplanes, and ships, for example, combined with new technologies in material and digital sciences, and business models such as ride-sharing and shared ownership.

Connectivity

Redefined mobility

Autonomous vehicles

Electrification

Four subsets

of innovation combining to

drive the industry’s transformation to mobility

Each of these factors is disruptive enough on its own and would require adjustments of business models, but when taken together they add up to an outright transformation of the industry.

This transformation represents significant opportunity, not just for OEMs and savvy Tier 1 and Tier 2 players within the industry, but also new, non-traditional players emerging from the technology space. We anticipate that there is considerable revenue to be found in the automotive/mobility industry in the next five to 10 years—an increase of up to 30% of the existing revenue pool, or $1.5 trillion USD[1], by one prominent estimate.

However, the transformations coming for this industry are so broadly disruptive that companies in the automotive value chain that do not move fast enough will find themselves permanently behind and unable to compete. This could potentially upset the landscape, players, and power dynamics within the industry.

In short, the transition to the “mobility” industry is fundamentally changing how the automotive industry operates, thinks, and is perceived. This change is part evolution and part revolution, and those companies failing to adapt may find themselves obsolete also-rans by the end of the next decade.

The savvy players within this industry will ride this transformation to compelling success, while those that move too slowly or fail to adapt may not survive to see the next era.

Revenue to be found in automotive/mobility

[1] http://www.mckinsey.com/industries/high-tech/our-insights/disruptive-trends-that-will-transform-the-auto-industry

2016 MAJOR EVENTS IN THE AUTMOTIVE INDUSTRY

Jan. 5

General Motors announces $500M investment in Lyft

Jan. 6

Ford announces Smart Mobility and 25 mobility experiments

Chevrolet reveals production model of 2017 Chevy Bolt

May 3

May 7

Chrysler and Google announce plans to develop 100 test Pacifica minivans with Google autonomous driving technology

Fatal accident in Florida in which Tesla autopilot is eventually cited as contributing factor

Sep. 9

Uber fleet of self-driving cars launches in Pittsburgh

Reports surface that Apple may be adjusting and scaling back its autonomous cars program and strategy

Sep. 14

Oct. 19

Tesla announces that all Teslas being produced now have full self-driving hardware

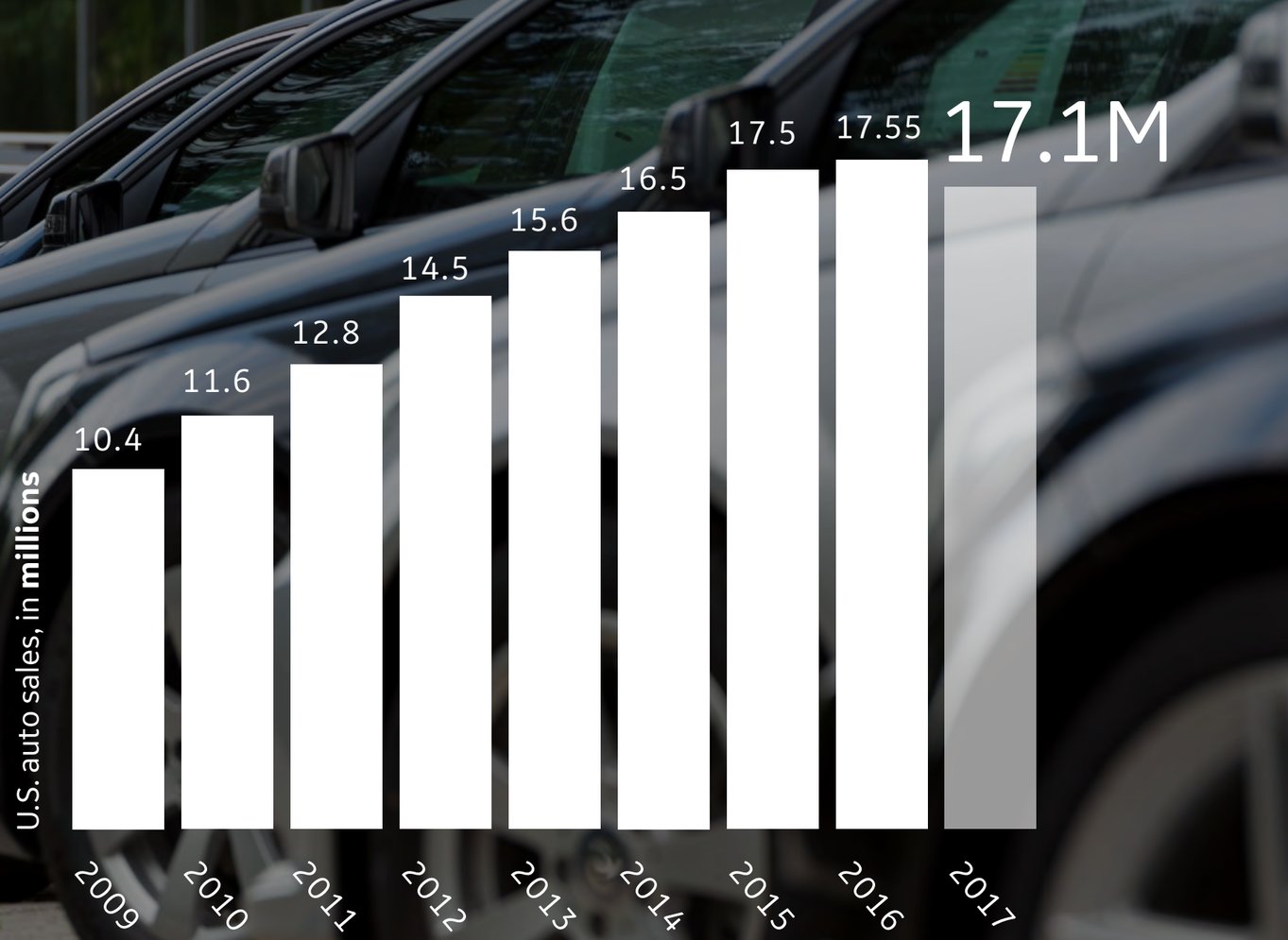
Oct. 25

General Motors announces it is incorporating IBM's "Watson" artificial intelligence into its OnStar product

Nov. 08

Tesla announces intention to buy Grohmann Engineering to bolster its production capabilities

2016 IN REVIEW



After six years of consecutive increases, 2015 was a record year in the automotive industry, with some 17.5 million vehicles manufactured in North America. 2016 started with predictions for an even bigger year in automotive sales. Preliminary 2016 totals are projected at 17.55 million (IHS.com projection). This will be an historical record for automotive production. IHS further projects 2017 to be approximately 17.1 million units. This downturn is thought to be part of a trend—production numbers will bounce up and down over the next few years—primarily due to large number of leases returing, combined with longer loan terms for consumers, and the large amount of inventory going into 2017.

Some analysts feel production volumes have peaked and will be flat for years to come. Perhaps due to greater engine efficiencies and the relatively low cost of oil (and thus gasoline), the light/utility truck categories in particular did very well across the world in 2016. As the year ended, 15 plants were running overtime in late December (NA), with only two of those being non-truck plants.

Looking purely at the traditional aspects of the industry and how they exist in 2016, it is clear that individual segments will continue to be driven by consumer behavior.

For example, for the immediate future low fuel prices will continue to drive the SUV/small truck segments to profitability, as consumers choose the convenience (or in some cases necessity) of size over gas mileage and efficiency. Goods transport will continue to drive large truck and small utility segments, which have experienced steady growth and should continue to do so.

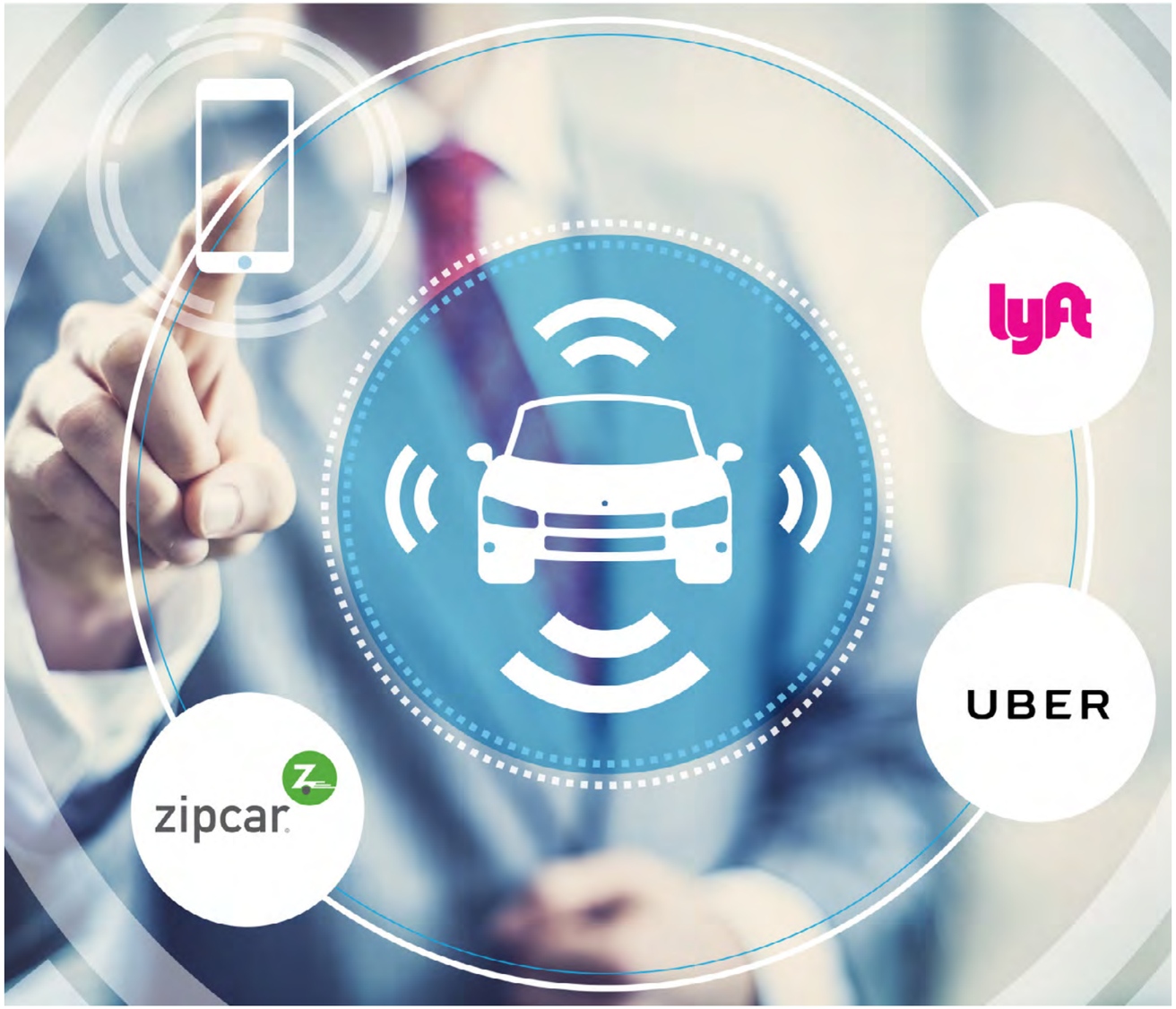
Hybrids—especially luxury hybrids—should see continued and consistent growth as the hybrid accelerates its move from niche interest to proven technology in which users now expect not only the hybrid engine but upleveled accoutrements and upgrades they have previously demanded only in vehicles in more traditional segments. For many consumers, a hybrid engine is no longer sufficient as the only motive to buy. They are looking for differentiating factors, and the industry has begun to deliver these differentiated vehicles.

But above sales and new vehicle production, the story of the year was being written at a much higher level. In the future, as historians assess the automotive industry in the 2000s, 2016 may well be seen to represent a turning point, a tectonic shift in the industry's development.

For the first time in well over half a century, the automotive/transportation industry is deep in the process of redefining itself and its purpose.

In 2016, there was a palpable shift among both industry insiders and outside observers toward describing automotive/transportation industry segments and players as the new 'mobility' industry.

The mobility industry, redefined, involves thinking more broadly about how consumers will engage the automobile or vehicle. The mobility industry is emerging as the next generation of products and services enabling the transportation of people and goods. These products and services include traditional products such as cars, trucks, buses, trains, airplanes, and ships, for example, combined with new technologies in material and digital sciences, and business models such as ride-sharing and shared ownership.



This shift to becoming the mobility industry may potentially result in something unseen in nearly 75 years—the emergence of truly disruptive OEMs in the industry. For nearly three quarters of a century, the basic OEM players within this industry have largely remained constant and similar. Some players (Studebaker, AMC, Packard) have disappeared or been acquired and phased out, while others (the Japanese and Korean makers) have emerged during this time—but none have had truly disruptive business models.

The OEMs that have emerged over the past 75 years into significant players have offered slightly differentiated versions of the same basic product offered by other, more established manufacturers.

But in this period that, over time, will be seen to have started around 2016, new players are emerging whose products and business models may be fundamentally different, and will require existing players to either vastly adjust their own models, or partner with these emerging OEMs in order to remain competitive. Tesla is the most obvious example for the moment—they are deeper into production, and have a truly disruptive direct-to-consumer sales model that should serve as an urgent wake-up call to the dealer community. But other players are making significant strides as well. In November, Chinese-backed startup announced plans for a $700 million factory in Casa Grande, Arizona, south of Phoenix—and followed up in December by unveiling the design for its electric vehicle, the Air. All the while, traditional OEMs continue to launch new EV products such as Jaguar's I-Pace, Porsche's Mission E, Mercedes-Benz' Generation EQ, and Audi's e-tron. Even players from non-traditional spaces, from Apple to Google to Uber, may significantly impact the mobility industry, either as OEMs, or as critical Tier 1 suppliers whose products and services are indispensable elements of a winning OEM strategy.

Four distinct and readily observable trends are driving the shift from automotive to mobility:

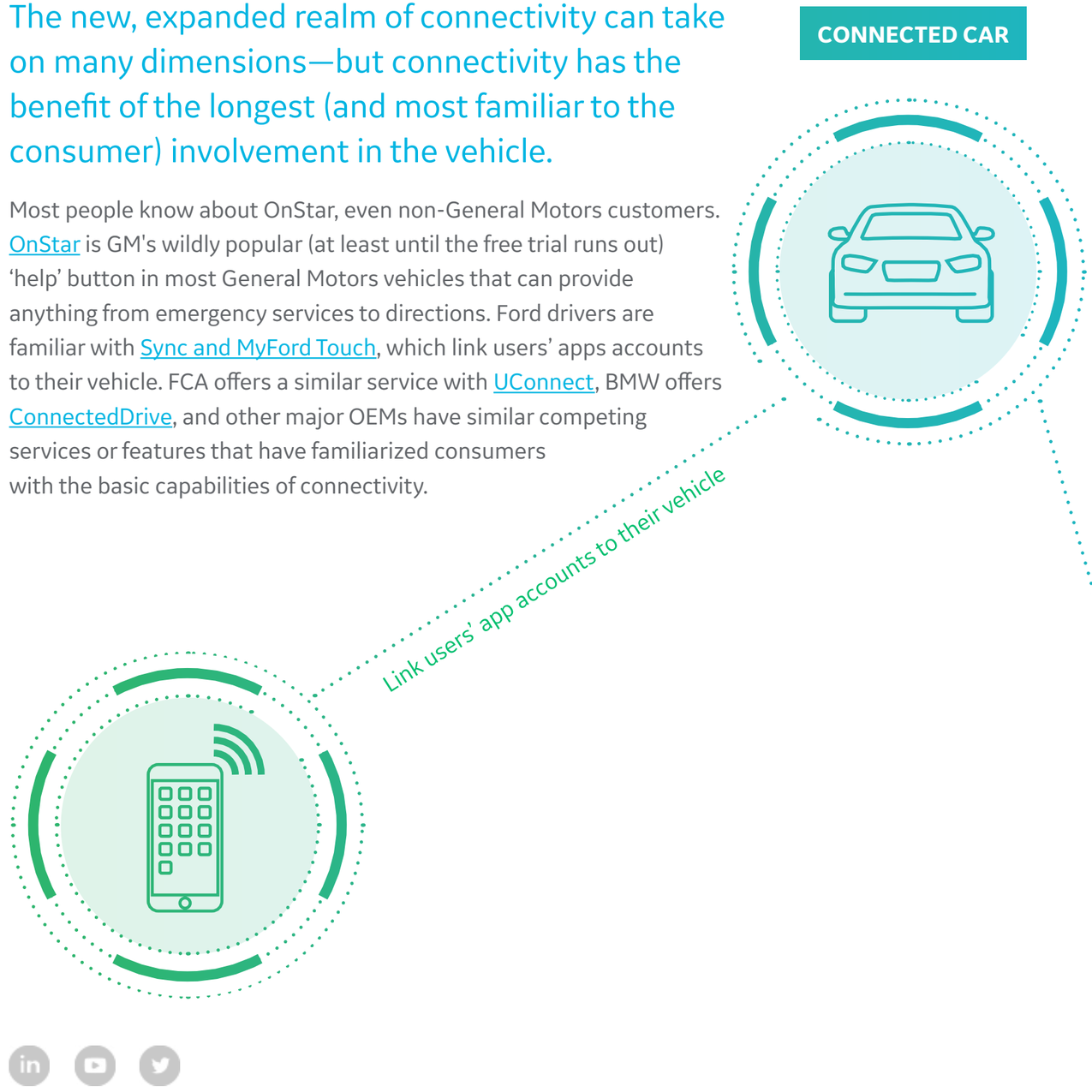
- **Connectivity**
- **Redefined mobility**
- **Autonomous vehicles**
- **Electrification**

These dynamics have been at play for some time, but in 2016 each reached an inflection point of some level, moving from the industry's distant future to its immediate future. Taken together, these areas are driving the shift in the industry's definition—and not only did they set the tone for 2016, but will even more prominently set the industry's direction in 2017.

Connectivity

The new, expanded realm of connectivity can take on many dimensions—but connectivity has the benefit of the longest (and most familiar to the consumer) involvement in the vehicle.

Most people know about OnStar, even non-General Motors customers. OnStar is GM's wildly popular (at least until the free trial runs out) 'help' button in most General Motors vehicles that can provide anything from emergency services to directions. Ford drivers are familiar with Sync and MyFord Touch, which link users' apps accounts to their vehicle. FCA offers a similar service with UConnect, BMW offers ConnectedDrive, and other major OEMs have similar competing services or features that have familiarized consumers with the basic capabilities of connectivity.



In 2016, OEMs continued to think seriously about matching consumer behavior with automotive services, such as knowing when a driver's vehicle needs gas and automatically recommending a service station that meets the driver's preferences—perhaps even identifies a station that features a car wash, is co-located with a McDonalds, Subway, or Burger King, or is next door to a Starbucks. This increased integration of consumer preferences and behaviors into in-vehicle services drove noticeable growth in the connectivity space in 2016—and led to some pretty impactful partnerships, like General Motors' partnership with IBM to infuse "Watson" into its OnStar system, opening up broader possibilities for the service to intelligently analyze both its own surroundings and user preferences.

Redefined mobility

Driven by the success of ride-sharing, Uber, Lyft, and other new business models—the very nature of what we consider "mobility" is shifting the definition of consumer engagement with the automobile or vehicle.

The signs of this shift are readily apparent. Despite some valid questions about its profitability and the sustainability of its ongoing losses, Uber stood to generate more than $5 billion USD in revenue in 2016. For its part, Lyft received a major shot in the arm when General Motors invested $500 million USD in its service. Some observers have suggested that when "purchase intent" mentions on social channels is analyzed, Lyft may be experiencing a growth rate more than double that of its rival Uber. And regardless of the financials, it's not in dispute that the phenomenon of ride-sharing and the companies that drive it, have captured the imagination of the automotive media and have been mainstreamed—to the point that "Uber" has become not just a noun but an adjective, with "Uberization" becoming a buzz phrase across most industries to describe the process by which a newly minted player in an industry thoroughly disrupts it—despite not having the capital or facilities of the traditional powers, but purely by implementation of a new business model.

The immediate impact of this changing engagement on businesses that manufacture and/or sell vehicles will be primarily around the financial construct of the engagement, and not so much the development and production of the vehicle—yet.

However, it is important to note that, in anticipation of changing consumer expectations about how they will engage with vehicles, most of the major OEMs are beginning to consider how these trends will impact their forthcoming development and design. This will result in some changes in both the physical development of vehicles and the software built to be inside them.

Autonomous vehicles

2015 marked the beginning of exciting progress and developments around autonomous vehicles.

2016 brought extensive coverage and sometimes breathless levels of hype, almost to the point of overselling the current capabilities of the technology. But as the year unfolded, industry observers, and even some consumers, have become more aware of the complexities and challenges ahead—specifically around safety issues, as well as both the technological challenges involved in AV and the political realities around the likely regulations and necessary standards in the space. These doses of reality have somewhat tempered the hype and over-sell of fully autonomous vehicles—but only somewhat. AV remains a compelling topic and storyline for the media and for consumers.

Interestingly, despite some predictions of massive disruption and jockeying for leadership in the autonomous vehicle space, 2016 also saw increased levels of partnership between traditional OEMs and the technology players emerging from Silicon Valley. Amid reports that Apple may be abandoning its vehicle project, Google struck partnerships with both Ford and Fiat Chrysler. BMW announced partnerships with Intel and the collision detection firm MobilEye. General Motors acquired Cruise Automation outright, and made a $500 million investment in Lyft, with both moves intended to bolster its autonomous vehicle efforts. While anything is still possible, it would appear that Silicon Valley and Detroit (and Tokyo, and Germany), rather than entering a bitter cage match for supremacy, are planning instead on working together to bring autonomous vehicles closer to reality.

This cooperation and partnership between OEMs and technology leaders is a key dynamic going forward—though this is perhaps a more jarring realization for the new, technology-based players than the traditional industry.

The OEMs have long integrated technology into vehicles, going back decades. Partnering with technology companies is an extension of a mindset, if not the actual model, that's been prevalent in the industry for a generation. The challenge for technology companies is that, while they are well ahead of the OEMs in terms of developing the technology to make AV work, they lack the manufacturing and supply chain capabilities and infrastructures to effectively dominate the AV market. For example, Apple's Titan project has suffered from false starts and problems associated with manufacturing capabilities. This will not present a long-term challenge for technology players, however, as co-manufacturing has been a strong trend in that industry. Take, for example, Google's new phone; they don't build the hardware, opting instead to co-manufacture with HTC.

In another example of collaboration across these two industries, Delphi Automotive plans to pilot two driverless ride-sharing programs in U.S. and Europe, with Boston, Pittsburgh, London and Luxembourg as the leading candidate cities for the pilot. Delphi further plans to expand the program to Singapore in 2018. For the first two years of operation, Delphi staff members will be assigned to each vehicle to monitor its performance in traffic.

Mobileye NV will provide obstacle detection software, and Quanergy Systems Inc. will develop a lidar unit. Intel Corp. will produce the computer chip that decides when to steer, brake, or accelerate. Ottomaticka Inc. (which Delphi acquired last year) will write the software for Intel's chip. The vehicles will have Delphi-produced radar and cameras.

Despite the cooperation, there are still some challenges. Seating is a key component that is under pressure for new technology, yet faces traditional pricing challenges. For example, Lear Corp. has dropped its business with BMW in its Spartanburg, S.C. plant, due to what Lear CEO Matt Cimoncini calls "irrational pricing". Magna International Inc. will take over production of seats for the BMW X5 and X6 cross-overs this year.

This all comes in the middle of challenging requirements for seating sensors that will augment AV technology. Sensing for driver conditions will be critical for autonomous vehicles.

Electrification

Electric vehicles have been improving steadily for the past few years.

But 2016 saw significant movement toward the mainstreaming of “EVs,” with improved battery technology, emissions standards becoming tougher and tougher, and the consumers who support the environmental movement demanding cleaner vehicles and better clean technology. The growth has been steady, but it has been slower than perhaps the OEMs and proponents of the technology would prefer to see.

There were certainly signs in 2016 that the EV market has reached a new high point. The 2017 Chevy Bolt was introduced to great fanfare and promptly won Motor Trend’s 2017 Car Of The Year award. Tesla claimed more than 276,000 pre-orders for the Model 3 in the first five days after revealing the vehicle, and nearly half a million to date. BMW, Ford, Chevrolet, Mercedes, Nissan, Audi, and other manufacturers continue to expand their EV portfolios. The buzz around electric vehicles dominated the Consumer Electronics Show in Las Vegas in January. And across the industry, a general sense has developed that EV’s have a permanent and expanding role in the future of the industry.

However, the EV market isn’t “there” yet. Hybrids, rather than true EVs, remain a bigger growth opportunity in the short term. Range anxiety among consumers and the limitations of current technology serve to restrain the expansion of the EV market somewhat. Without improved long range battery/power capability, and absent the kind of mass infrastructure investment to support greatly expanded use of electric vehicles, pure EVs will continue to show slow growth.

Battery and drivetrain technology will drive the electrification trend.

For example, FCA's (Fiat-Chrysler Automobiles) hybrid Pacifica, built in Windsor, Ontario, uses a 16-kWh battery pack made by supplier LG Chem that is stored below the second-row seats. It also uses a dual-motor variable electric transmission, developed in-house, known as the eFlite. The battery and minivan's innovative drivetrain give it an all-electric range of 33 miles and a full range of 566 miles (autonews.com).

Suppliers will be critical in providing electrification. FCA's CEO Sergio Marchionne says "The single largest drawback to electrification to us as OEMs is that we're no longer in control of the components side; all batteries will be made by others. It's really a question of capacity and access to that capacity."[2]

These dynamics are shaping a new supply chain model for an industry that has finely tuned it's supplier relationships for over 100 years.

Which countries are leading the electrification effort? Norway has 100,000 EV's on the road today. That's 3% of its 5.2 million vehicles—far surpassing other western developed countries. They have achieved this by offering leading incentives for EV owners, through lower road and value added taxes, levying no charges for EVs on toll roads and ferries, allowing EVs to park free in municipal lots, to use bus lanes, and for companies using EVs in their fleet to pay 50% less in company car taxes. Norway is targeting 400,000 EVs on the road by 2020, and has passed an outright ban on fossil fuel-powered cars by 2025 (prompting a tweet from Tesla's Elon Musk: "What an amazingly awesome country. You guys rock!")

For its part, Toyota says it will replace at least 60% of its lineup in major markets by the end of 2021 with more powerful and economical powertrains. Toshiyuki Mizushima, president of Toyota's Power Train division, says "We'd like to differentiate ourselves from others in terms of the value-added technology, further evolving the engine and transmission."

With both national governments and private sector companies driving such significant shifts toward electrification and greener propulsion, we anticipate significant opportunity in the electrification space for both OEMs and Tier 1 and Tier 2 suppliers in the next five years—as well as significant risk for those companies in industry that do not move quickly enough to match the shifts in market expectations.

[2] http://www.autonews.com/article/20161226000100/OEM06/312269966?template=print

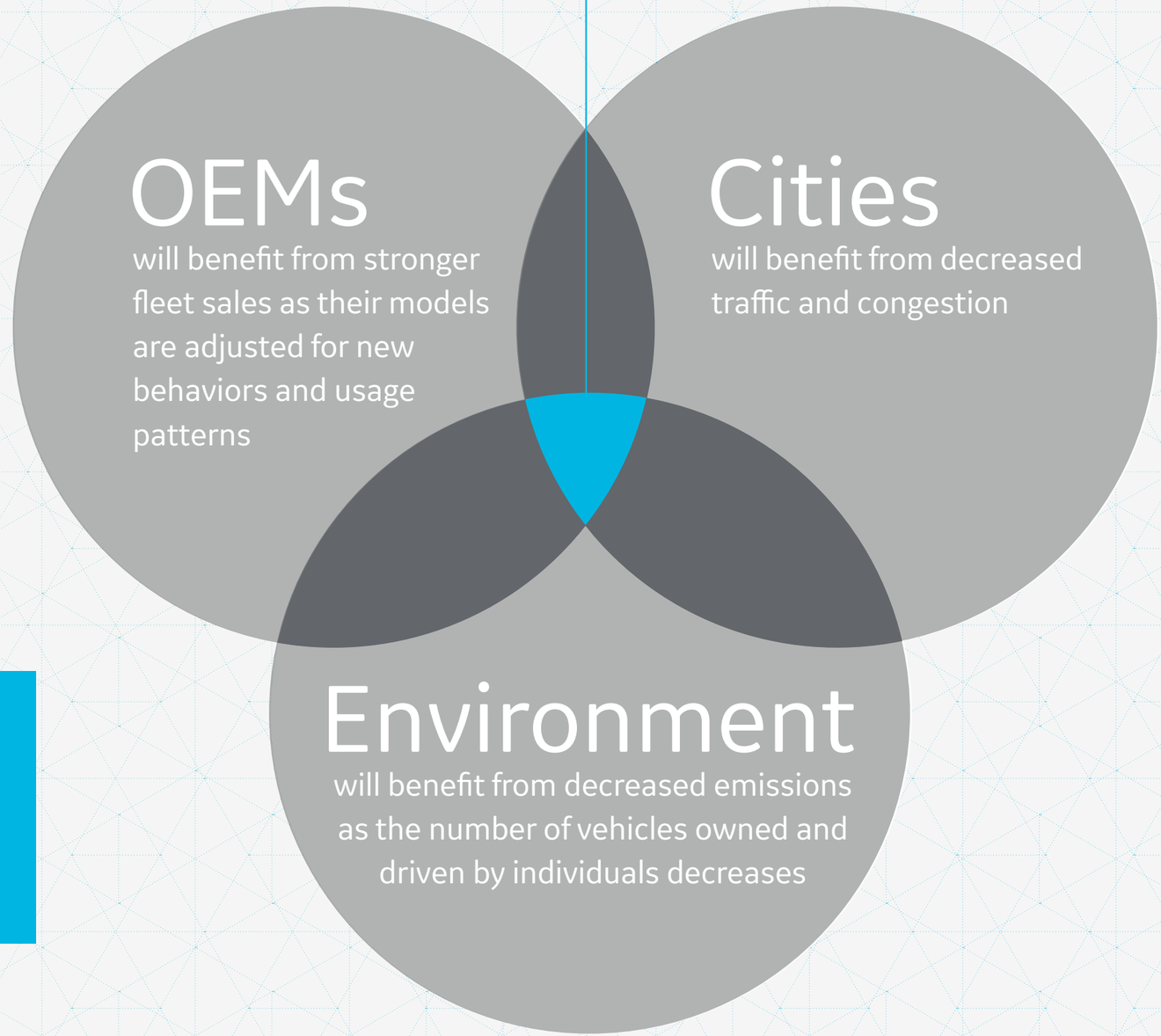
WHAT'S AHEAD IN 2017

While there has been a strong and steady rise in the overall volumes of vehicles sold worldwide, and especially in the United States, the industry should not expect such explosive growth over the next few years. This is not to say that the market will contract; to the contrary, we do expect to see continued overall growth in 2017. In the remaining years of this decade, we predict a flattening of the broader vehicle production and sales volumes—but overall growth will still increase, fueled by newer 'micro' markets established by the new mobility.

Ridesharing, for example, is seen by many observers as a

WIN-WIN-WIN

for the players involved.



Even with the eventual emergence of autonomous vehicles, anticipated heightened interest from municipalities, as well as from businesses desiring fleets to serve these emerging usage and engagement patterns, we expect overall sales of new AVs will make up for the drop in sales of traditional vehicles owned by a single person.

Nissan CEO Carlos Ghosn has described the challenge facing traditional OEMs as “how to put new technologies into a car while continuing to deliver on classic expectations.” Connectivity technologies represent the industry’s opportunity to accomplish the delivery of some classic expectations even in an environment where the nature of vehicle ownership is changing.

Connectivity

One of the classic appeals of the automobile has been its role in supporting individual expression and freedom. For generations, kids in America have dreamed of the rite-of-passage moment when they get the keys to their first car; it has represented maturity, freedom, and recognition as an individual approaching adulthood. Buying a luxury vehicle is often a person’s “reward” to themselves for having “arrived” after landing a promotion or a high salaried job. Vehicles like the Prius attracted buyers who didn’t just like the car, but liked what it signaled to observers about the buyer’s personal values or beliefs. People even often christen or name their vehicles. The vehicle as individual expression is one of the classic cultural expectations of the industry.

And yet, as we have seen, trends and surveys suggest that between ride-sharing and the rise of autonomous vehicles, the concept of individual ownership of a vehicle may decline in appeal over the next decade or more. How, then, ought the mobility industry use new technologies to deliver on this classic zeitgeist of individuality while still embracing the shifts in consumer engagement of the vehicle?

While connectivity is about much more than merely personalizing the in-vehicle experience and enabling the user to extend their own environment into a vehicle, one of its primary appeals is that it allows the industry to achieve Ghosn’s mission of using new technology to deliver on some of the classic expectations.

Via the integration of mobile information to a vehicle (not just one specific vehicle, but any vehicle the user is engaging at the time), a level of individuality is provided for the user, even when ride-sharing or riding in an autonomous vehicle.

Upon entering a vehicle, a user's personal information is made available to them through an open—yet secure—technology framework that provides the vehicle that user's personal preferences, from the selection, operation, update, and service of different "services" (think Sirius, Pandora, Fox/CNN etc.), to future services like predictive maintenance options to monitor and warn consumers about operational performance of the vehicle.

When autonomous technology is integrated, personalization takes on an additional element of productivity. A user in any vehicle would be empowered with the capability to check emails, voice mails, other messages, to make calls, work on presentations, or otherwise gain back time for productivity that has been traditionally lost to the commute.

These services can be made available to single owner vehicles through a one-to-one paid service, or to ride/ownership sharing vehicles via a one-to-many paid service. In such a service, in order to sync with the vehicle, the user might need to acknowledge a service agreement to access their data, information, and preferences that then is made readily available in the vehicle they are traveling in.

Building these kinds of services is most likely a bigger opportunity for Tier 1 suppliers than ever for OEMs. Auto manufacturers that are developing connected car capabilities have become very smart about how to drive new business and service models—and they are looking for component suppliers to provide new technologies they can embed in the already exhaustive amount of computerization technology currently in place in most vehicles.

This phenomenon has driven the need for a platform to design, develop, and deploy these new connectivity solutions—an Industrial Internet of Things (IIoT) platform that is secure, yet open and scalable, in which an OEM or brand management company can offer an integrated experience for the consumer that simplifies all the connected services available in a vehicle.

These services are made possible by the ever-growing amount and sophistication of sensors in all types of systems in a vehicle, all of which will need to be predictable, repeatable, and scalable to tens of millions of consumers. OEMs will need a platform beyond Microsoft's Azure, Amazon Web Services (AWS), or IBM to deliver the experience/outcome consumers will demand—and that's where the supply chain can realize significant opportunity.

There is one final aspect to these kinds of connectivity services that will have a consequential impact on all of the industry's players—the importance of data and the role it will play in connectivity. Unquestionably, the personalization of the in-vehicle experience—as well as the development of the kind of technology necessary to make autonomous vehicles practical as a mass solution—will generate, by some estimates, up to two petabytes of data per vehicle per year. At sales volumes between even 15 million and 17 million in the United States alone, the mobility industry could be generating up to 30 zettabytes of data annually within the next few years.

Seamlessly managing all this data is the ground level of digital transformation in the mobility industry. Connectivity to digital data will rule the driver engagement segment. OEMs are developing the platforms for the inevitable availability of ubiquitous internet connectivity, which will drive the availability and use of all types of data, and services providing this data. Tier 1 suppliers, too, are working to add the capability to provide these platforms and/or services.

CONNECTIVITY TO DIGITAL DATA WILL RULE THE DRIVER ENGAGEMENT SEGMENT

Not only do OEMs and Tier 1 suppliers need to scale up their data capabilities to be able to process that sheer volume of data, but the industry will need to settle the issue of who owns that data.

Within those mountains of data will be customer insights that not only can improve retention and drive purchases for mobility industry players, but that partners from quick-service food companies, to hospitality companies, to service station and oil companies would pay a king's ransom to access. Control of the data generated by ubiquitous connectivity could be a kingmaking factor in the next decade of the mobility industry. In fact, we maintain that data is the most important Tier 1 key to growth over the next decade; a Tier 1 supplier that is able to not only build the platforms and services integrated into vehicles, but maintain control of the data generated in the process, will experience massive growth and expansion in the next few years. OEMs might love to control it themselves, but it may be the Tier 1s—either existing or emerging—who sit in the most lucrative position when it comes to data.

Tier 1 suppliers that want to lead, or even merely remain relevant, in the age of connectivity and digital data must—if they have not already—develop and articulate their digital transformation vision and strategy in 2017, and begin concrete and demonstrable action to begin activating it. This will involve not only investment in technology, but in the right people to envision and plan their digital transformation strategy, and to get the entire organization bought in and following the plan. Identifying or hiring the right people, augmented by consultants if and when necessary, is as critical to a Tier 1 supplier's long term success over the next decade as its core competencies have been to success over the past generation.

The ceding of data ownership to Tier 1 suppliers may not be as big a detriment to the OEMs as it might seem on a surface level. Whoever ends up owning all this data is also going to be responsible for securing it—and that's going to take significant investment. The U.S. government is aware of the concerns and challenges around making all the data generated by the industry in the coming years, and in October the National Highway Traffic and Safety Administration (NHTSA) issued its first guidance to the industry relating to privacy and security, as well as ensuring safe vehicle operation even when a breach has occurred. Many of the major U.S., German, and Japanese OEMs are involved in the Crash Avoidance Metrics Partnership (CAMP), which in January issued its first proof of concept for a security protocol around connected vehicles.

The industry is obviously aware of the scale of the challenge facing it—and the necessity of addressing it simultaneously with the development of the technologies that will make connectivity (and autonomous operation) possible. But industry players should probably anticipate requiring a concerted effort to educate the public about the precautions and protections in place—not just over in-vehicle operation, but concerning the individual information (especially any personally identifiable information) collected and applied within vehicle personalization.

Redefined mobility

While 2017 will see continued growth and expansion of the business models that are driving redefined mobility, the deepest and most lasting impacts may still be a few years down the line.

However, the industry is already pivoting smartly to adjust for where the trends suggest we are going.

For example, people worldwide are increasingly living in cities; many anthropologists and demographers suggest that up to two thirds of the Earth's population will live in an urban setting by 2030. This will drive the need for smaller and more convenient mobility solutions. 2017 will see the expansion of ridesharing–the Uber, Lyft, and Zipcar business models–as well as higher revenues achieved by the established players in the space.

OEMs will accelerate their development of subcompacts and vehicles more aligned with operating in an urban environment—and there may well be concepts introduced during the 2017 auto show season of luxury subcompacts, taking the segment from being focused largely on function to also emphasizing form. And of course, both traditional automotive players and new forces from the technology industry will drive the continued march toward making autonomous vehicles a practical reality.

In fact, many of the major OEMs have made strategic executive hires specifically to support mobility. In September, Ford appointed former 3M executive Raj Rao to lead its Smart Mobility division; in January, General Motors announced its full Maven brand around mobility and placed well-regarded executive Julia Steyn in charge of it, while Renault-Nissan hired former Nokia and Motorola executive Ogi Redzic for the role of leading its mobility solutions. Other manufacturers continue to position key executives within their own mobility divisions.

The exercise of redefining mobility, and the entire industry around it, will be a process that plays out over time, a gradual evolution of the industry that occurs over a decade rather than a revolutionary change that radically disrupts the industry over any given twelve-month period. But the transition is inevitable, and is underway—and 2017 should see a number of additional moves in this direction.

2017 WILL SEE THE EXPANSION OF RIDESHARING—THE UBER, LYFT, AND ZIPCAR BUSINESS MODELS

Autonomous vehicles

The autonomous vehicles segment will continue to mature in 2017, generating even more media attention and consumer excitement.

However, both the segment's innovators and the general consumer base has become more fully aware of the complexities and challenges involved in making autonomous vehicles a broader reality. To overcome these complexities, much greater investment in research and testing is necessary—and this research is proving exponentially more costly and time-consuming than many consumers, or even many of the technology players involved had realized. These factors currently are hindering the predictability, repeatability, and scalability that will drive the eventual expansion of autonomous vehicles, and so we anticipate that AVs will have little to no impact on current platform technologies that OEMs have in full production in 2017.

That said, all six levels of autonomous driving have already impacted automotive industry players, both OEMs and suppliers—primarily around safety features already familiar to consumers, such as lane and parking assist, rear-view cameras and automatic braking. These technologies will move even further in 2017 from features available only in higher trim packages to core features expected by consumers at virtually every price point; they have reached a normalization point and are now seen by much of the public as integral features whose absence might deter a vehicle purchase. Managing these technologies throughout the value stream, from design to service, will provide significant opportunity in 2017 to suppliers at all levels of the value chain.

Levels of autonomous driving[3]

Automated system has no vehicle control, but may issue warnings.

Driver must be ready to take control at any time. Automated system may include features such as Adaptive Cruise Control (ACC), Parking Assistance with automated steering, and Lane Keeping Assistance (LKA) Type II in any combination.

The driver is obliged to detect objects and events and respond if the automated system fails to respond properly. The automated system executes accelerating, braking, and steering. The automated system can deactivate immediately upon takeover by the driver.

Within known, limited environments (such as freeways), the driver can safely turn their attention away from driving tasks.

The automated system can control the vehicle in all but a few environments such as severe weather. The driver must enable the automated system only when it is safe to do so. When enabled, driver attention is not required.

Other than setting the destination and starting the system, no human intervention is required. The automatic system can drive to any location where it is legal to drive.

[3] https://en.wikipedia.org/wiki/Autonomous_car

In order for autonomous vehicles to reach their full market potential, the existing technology and capabilities must be improved and made more predictable, repeatable, and scalable—so that all players involved, from fleet managers to commercial buyers to individual consumers have greater confidence that performance experienced on a test track in Silicon Valley will be similarly realized—every time—in the shipping yards of a logistics company in the Midwest, or on the parkways and commercial arteries in the Northeast.

The cold water in the face is a wake-up call around the current limitations of autonomous vehicle technology and the costs involved in overcoming those limitations may have led to a slight "trough of disillusionment" phase for AVs. But this disillusionment is only temporary and will give way quickly as milestones are achieved and new levels of performance are reached, and we see no slowing of development.

The most significant challenge is in fact not achieving any given desired technological result itself; concepts are being proven out in test environments often enough to warrant great optimism. The challenge is simply in making sure that each step in maturing the technology—and its adoption—is predictable, repeatable, and scalable. When the answer to the question, "Can we expect this same result every time in a broader, real-world environment and at scale?" is "yes," we will reach an inflection point in autonomous vehicle proliferation.

Another challenge that must be addressed that surrounds the growth and expansion of the AV market is determining the regulatory environment in which these vehicles will be produced and operated. Current laws are all built around vehicles that are controlled solely by the operator; adding any level of autonomous driving means introducing an element not covered by existing regulation. While the owner/operator will always be responsible for operation of the vehicle, regulations for OEMs and fleet managers will undoubtedly increase based on continued use cases of fully autonomous vehicles.

Can we expect this same result every time in a broader, real-world environment and at scale?

"YES"

As algorithms and software becomes increasingly responsible for determining vehicle response during potentially dangerous situations, regulatory scrutiny is certain to intensify around their development and implementation.

Additional areas that might be subject to closer examination include building security and privacy into vehicle and software design, and the effect of autonomous vehicles on jobs and the economy. Some analysts[4] have warned that the autonomous era could impact millions of jobs in the United States alone, as the need for manual vehicle repairs decreases, professional drivers (taxis, long-haul truckers) become somewhat obsolete, and the insurance industry has less need for adjustors. The question is whether federal and state governments can effectively walk the line between ensuring occupant safety and not stifling innovation.

The development of the right kind of regulatory environment around autonomous vehicles—one that ensures safety but does not overly restrict innovation and testing—is significant enough that Apple, a rumored major player in AV development, was compelled in November to submit a formal letter to the National Highway Transportation and Safety Administration (NHTSA). In the letter, Apple acknowledged its excitement and optimism around machine learning and transportation, and urged regulators not to impose too many restrictions on testing of self-driving cars. Furthermore, Apple seemed to acknowledge a concern that non-traditional players might be subject to greater scrutiny around self-driving technology—and urged NHTSA not to impose limits on testing that Apple sees as disadvantageous to the industry's newer players. "Established manufacturers and new entrants should be treated equally," the company argued in its letter.

Apple's November letter placed it among a number of both OEMs and technology companies raising flags about proposed NHTSA policy on autonomous vehicles, as well as efforts by state officials in California to require mandatory compliance with NHTSA safety assessments.

Once the technology has achieved the required consistency and can scale, and the regulatory environment has been determined to the satisfaction of safety and legal experts as well as the industry players themselves, the opportunity for AVs is boundless. There are several segments that make sense as lucrative initial target markets for AV technology.

Among these are:

Mobility challenged communities for whom driving is difficult, unsafe, or impossible

"First user" and early adopter consumers who like being in early on hot, new, trendy 'got-to-have-it' technology

Warehouse truck 'yards' where trailers are loaded and unloaded repeatedly, with definite route segmentation for safety

Seniors who don't want to or are unable to drive safely anymore

New segments of special interest include: small urban vehicles or fleet AVs

[4] http://www.latimes.com/opinion/op-ed/la-oe-greenhouse-driverless-job-loss-20160922-snap-story.html

Finally, an important element to the long-term success and proliferation of autonomous vehicles—similar to electric vehicles—is the willingness and commitment by municipalities and governments to invest in the underlying infrastructure needed to support AV at large scales, such as AV lanes, off-ramps, AV-specific parking scenarios, and so on.

Electric vehicles (EV)

While there is significant hype around the EV segment, 2017 will prove a year where the excitement is more justified than ever. With the Chevy Bolt now offering over 230 miles per charge, Tesla claiming almost a half-million pre-orders for the Model 3, the fast growth of the hybrid market with more and more options available to consumers, and other OEMs charging forward with their own electric portfolios, many believe 2017 could be a watershed year for EVs.

Even with these positives to look at, however, enthusiasts and observers might do well to slightly temper this optimism. The strength of the EV market in 2017 and for the next couple of years remains to be seen; there are significant challenges in moving from a small, niche segment of the market, as EVs are today, to a full-on industry or market takeover, especially in light of the continued low cost of oil globally. Historically, when the price of driving a traditional combustion engine vehicle is not prohibitively high or doesn't approach levels where drivers feel a pinch, EV sales lag a bit slower than expectations. Should the per-barrel price of oil remain low, we might expect a shallower adoption curve for EVs regardless of the extent to which the technology behind them matures.

This said, we expect that EVs will continue to drive new demand in the market in 2017; we do forecast steady growth in the EV segment over the course of the year and do not foresee any interruption in the advancement and maturity of the technologies that make EVs increasingly practical options. Most OEMs and Tier 1s have started their R&D on E-drive technology. As the most expensive system in a vehicle, the drive-train will be one of the components with the most change and impact on vehicle cost—and these changes and price fluctuations must be effectively managed if EVs are to succeed as a mass-market segment.

Battery range has traditionally been one of the biggest obstacles to broad market adoption of, or consumer comfort with, electric vehicles.

The industry is closer than ever to overcoming this obstacle. Battery technology is continuing to improve, as the Chevy Bolt and Tesla Model 3 demonstrate. Still, current battery technology allows an average range of 100-200 miles; for the market to see significant mass adoption, most analysts believe that the average range will need to improve to 300-400 miles on a single charge. For now, battery technology companies are probably two to three years away from doubling the mileage of EVs.

This gives governmental leaders at every level, in partnership with the industry and potentially some NGOs, a brief window of opportunity to get out in front of addressing the other major hurdle to clear before EVs likely experience mass adoption: the need to build a sufficient and convenient infrastructure to support high numbers of electric vehicles on the road. This infrastructure must include everything from building mass charging stations capable of supporting dozens or even hundreds of vehicles at once, to developing the utility grid and power sourcing necessary to provide additional electricity to power millions of electric vehicles without inordinately taxing the rest of the power grid.

Without mass charging stations, most consumers are not truly comfortable in purchasing a full EV as opposed to a hybrid; the concern about going someplace and not being able to find a station to charge their vehicle enough to return safely home is enough to give many potentially interested consumers pause. And without the additional power generation capability to support high numbers of electric vehicles on the road, even a complete charging infrastructure may not be sufficiently supplied to support the increased demand. Addressing these infrastructure issues is critical to driving mass adoption of electric vehicles—and if the political and community leadership isn't there to ensure that infrastructure, EVs will not reach their full use potential.

The infrastructure challenge is not unique to EVs; hydrogen fuel cells are another promising technology that could move automotive further from fossil fuels, but they too have yet to reach mass adoption due to the lack of existing or proposed infrastructure, as much as or more than the need to beat the issues around immature technology issues. ironically, the biggest obstacle to mass adoption of cleaner or "greener" mobility solutions may not be overcoming technology challenges, but generating the political and municipal will to build the infrastructure to support mass adoption of these technologies.

THE BOTTOM LINE: without 300-400 miles per charge and mass infrastructure, EVs will continue to show steady but slow growth. In 2017, significant progress will be made toward conquering the technological challenges inhibiting mass EV adoption; whether the infrastructure needs are adequately addressed is yet to be seen.

SIGNIFICANCE

With the heavy media attention and high levels of consumer fascination around autonomous vehicles and the connected car, the automotive/mobility industry will have a high profile as it tackles the issues surrounding data security and privacy. Leaders from other industries would do well to pay close attention to the solutions developed or applied by automotive/mobility in this area—and be prepared to "borrow" these solutions or adapt them for their own industries as the IIoT generates ever-increasing levels of data for their own companies and products to handle.

About Victor Kingery

Vic has over 30 years of manufacturing, IT, and OT (operations technology) experience in Operational Excellence with manufacturing companies across the globe. He is a key thought leader within GE Digital, specializing in manufacturing operations. Vic is helping drive industry solution requirements for the GE Digital products, while leading engagements with analysts, industry experts, customers, and expert media publications.

About GE

GE (NYSE: GE) is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive, and predictive. GE is organized around a global exchange of knowledge, the "GE Store," through which each business shares and accesses the same technology, markets, structure, and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology, and scale, GE delivers better outcomes for customers by speaking the language of industry.

Contact Information

Americas: 1-855-YOUR1GE (1-855-968-7143)
gedigital@ge.com

www.ge.com/digital