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# AUTOTECH REVOLUTION

**AN INSIDER'S VIEW OF THE DYNAMIC AUTOMOTIVE TECHNOLOGY MARKET**

## WHAT'S INSIDE...

# THE AUTOTECH MARKET

Automotive technology (autotech for short) is one of the most dynamic markets today, with massive amounts of change to industry norms, automaker strategies, and relevant players. It promises correspondingly dramatic outcomes for people's individual mobility options and worldwide transportation networks. This e-book looks at the most important trends happening today and how they're affecting the industry from an insider's perspective.

# TABLE OF CONTENTS

# NEW MOBILITY

## Why innovation and production are a reluctant couple

The word mobility has been co-opted by the broader automotive, technology, and transportation industries to encompass a wide range of personal attitude shifts, new technology deployments, and experimental business models. It is arguably the most transformative change facing us today. But what exactly is mobility, and why is it taking over conversations across the globe?

## Expanded view of transportation

At the heart of the new mobility movement is an expanded view of personal transportation and how to deliver it. While individual ownership of internal combustion engine vehicles has been the predominant solution in the developed world for decades, this option as the sole choice has slowly been augmented in the public's mind through changing attitudes and exposure to practical alternatives.

## New business models

Companies are now successfully providing partial ownership, subscription models, as well as car and ride sharing options that make car ownership seem like a burden rather than a luxury. Electric vehicles have finally broken into the mainstream consciousness — in part thanks to rising climate change awareness — and have become viable consumer choices. Last-mile options like e-bikes and scooters have become fashionable among urbanites, millennials, and the tech-set, bringing with them an accompanying lift in combining public and personal transportation modes within a single trip. From every angle you consider it, "new mobility" is challenging the dominance of the traditional automaker's worldview.

Automakers are meeting this disruption of their industry with a variety of reactions. Most are exploring remaking their business model, customer relationships, or vehicle line-ups, as well as experimenting with new business opportunities that use their highly developed technologies and production systems to provide various alternative transportation options.



**New mobility is challenging our concept of transportation and lowering the barrier to entry for newcomers in the automotive market.** Image: Wikipedia.

> From every angle you consider it, "new mobility" is challenging the dominance of the traditional automaker's worldview.

Some are exploring vertical markets outside personal mobility such as house batteries for smart homes, while others are looking to leverage their brand in general consumer products such as watches and golf accessories. All of them are looking for investments into startups to find the next nascent Uber or Waymo. These acquisitions can be large investments that provide highly uncertain payoffs.

**DESPITE THE RISK, STARTUP ACQUISITIONS AND INVESTMENTS GIVE THE OEM A WAY TO COMPETE AGAINST THE SHINE AND SPARKLE OF STARTUPS AND TECH COMPANIES.**



**Motor City and Silicon Valley are learning to play on the same team to productize solutions that are innovative as well as safe and reliable.** Image: Wikipedia.

## Value of OEM experience

While automakers struggle with disruption, tech companies struggle with the opposite side of the coin — how to operationalize their visions. It's widely acknowledged that building an electric powertrain is orders of magnitude simpler than manufacturing an internal combustion engine, however creating a successful car company is difficult regardless of how that car propels itself.

While automakers struggle with disruption, tech companies struggle with how to operationalize their visions.

## Startup interest and uncertainty

The difficulties of integrating Silicon Valley cultures into large existing corporations have led to many sputtering attempts and failures. Despite the risk, startup acquisitions and investments give the OEM a way to compete against the shine and sparkle of startups and tech companies. They feed a public relations engine that helps underscore an automaker's strategy of embracing new mobility to Wall Street investors. Startups also provide an easy way to harvest technologies and patents from sources outside the automaker's own R&D organizations.

Players like Google, Apple, Uber, Tesla, and a flock of hopeful others believe that they can do better than the traditional OEMs, leaving the tech companies to learn the lessons of just-in-time manufacturing, supply chain management, statistical process control, and total quality management.

## Startup innovation value-add

This said, startups definitely bring something of incalculable value to the table. They shake up the system with a brand-new way of approaching "long-solved" problems, pushing the industry forward in a way unfettered from the shackles of massive existing systems and supplier networks. They look at business models that aren't powered by dealerships. They envision the car as a software platform rather than a mechanical assembly. They use the cloud as a key component rather than a bolt-on customer portal. They are flexible in their working partners and exploratory ventures in a way that has been unimaginable by an OEM.

## Transformation requires a village

Both OEMs and tech players bring critical components to new mobility. Silicon Valley understands the software, while Motor City (and their global counterparts) understands the mechanics and production. Moreover, they both come to the table with different skills, attitudes, and cultures. Once innovation and production truly synergize, we'll see a successful transformation of transportation. ◼

While tech powerhouses seem to be successful at morphing public opinion by rolling out disruptive features that slip through governmental loopholes, they must still build products that conform to the many existing consumer and environmental regulations under which automotive stalwarts have learned to flourish.

# ACES

## Autonomous, connectivity, electrification, and sharing

The four pillars of new mobility are autonomous, connectivity, electrification, and sharing (ACES). As these subsegments underlie much of the disruption of the industry, it is critical to have a basic understanding of how automakers are responding to each.

## ACES | Autonomous
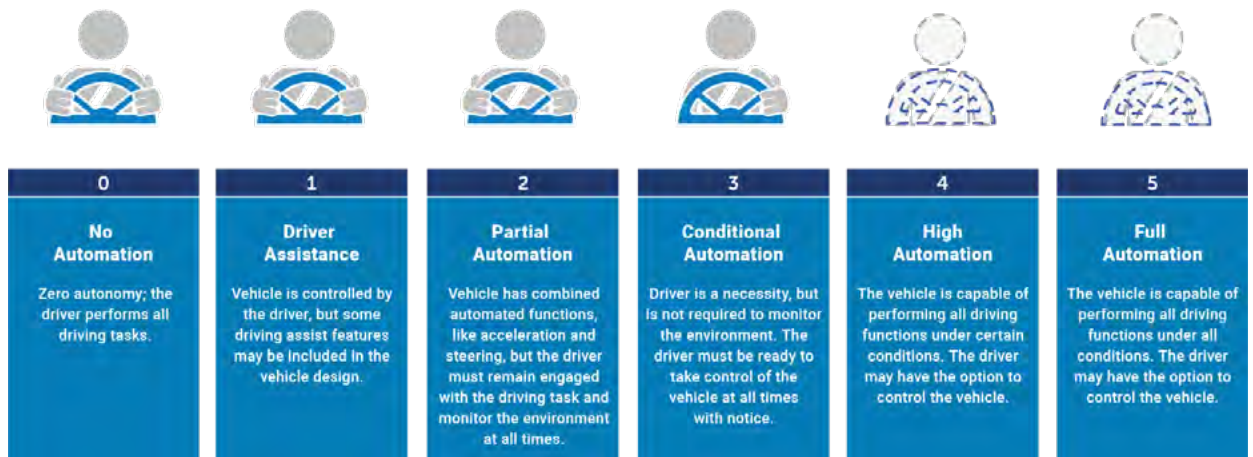
### Confusing classifications

Fully autonomous driving is the holy grail of the auto industry; more specifically, reaching fully self-driving vehicles without any human intervention. SAE International, formerly known as the Society of Automotive Engineers, calls this level of capability **level 5**. While SAE's classification system has been adopted by most inside and outside of the industry, is criticized by some as either leaving out critical aspects, being unable to conclusively determine levels for any given technology, or providing misleading terminology to the public. Notably, few car makers are willing to publicly assign their vehicle's capabilities to any SAE level. While alternative categorizations have been proposed, currently none of these are as thoroughly defined, researched, or widespread as SAE's autonomous levels, which remain the standard reference point.

Autonomous capability is part of nearly every automaker's deployment roadmap, and they are all pushing hard to get there with active R&D, patents, and demonstrations. Without some interest in self-driving capabilities, OEMs are viewed as old-guard metal benders or piston pushers, stuck in the non-digital world.

### Anti-autonomous approach

Some muscle and sports car brands lean into an "anti-autonomous" image to distinguish themselves from the pack, attempting to appeal with a "humans need to drive" message to those aspirational race car drivers that would rather have the steering wheel pulled out of their cold dead hands than delegate the driving task to a machine. This anti-autonomous distinction is, for the most part, brand positioning. Even automakers like Porsche that have a brand built around the driving experience have autonomous tech in their roadmap — nobody wants to be left behind in this new revolution.

### SAE LEVELS OF AUTONOMY



| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **No Automation** | **Driver Assistance** | **Partial Automation** | **Conditional Automation** | **High Automation** | **Full Automation** |
| Zero autonomy; the driver performs all driving tasks. | Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design. | Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times. | Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice. | The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle. | The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle. |

**SAE's classification system is imperfect; however, it remains the industry standard.** Image: SAE.

**ADAS sensors are proliferating in a bewildering array of disparate features – sensor fusion is one way to get them under control.**
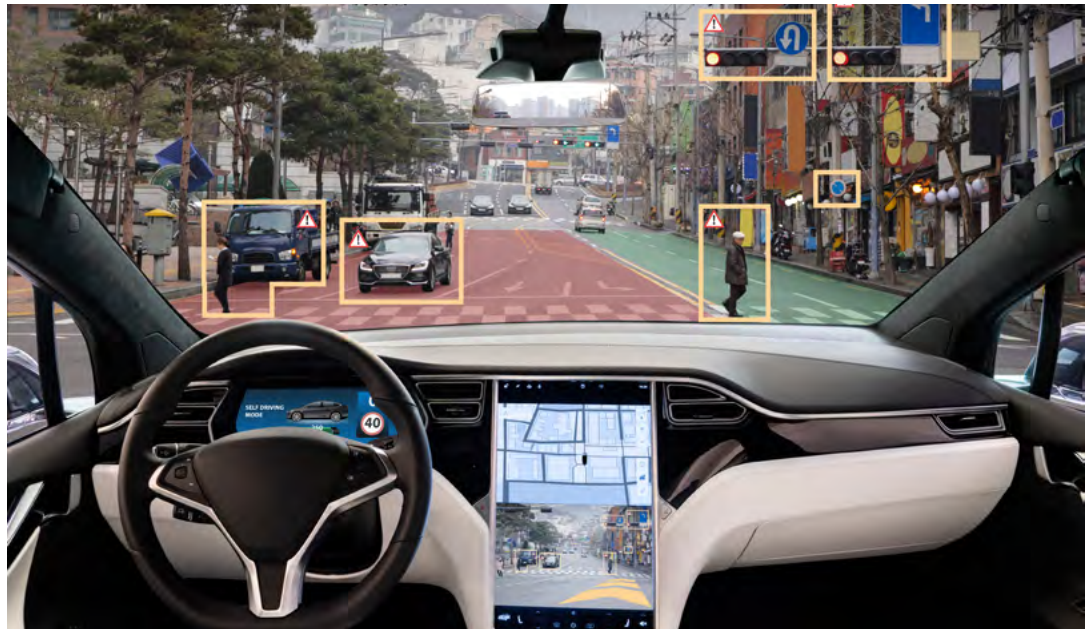
Self-driving need not spell the death of human-driven cars either. Nearly all traditional automakers believe a design that allows some switching between self-driving and manually driven will be the best interface for some time to come. This solution can handily deal with people hesitant to adopt autonomous as well as initial technology limitations from systems with less than SAE level five performance.

### The advanced sensors of ADAS

Because **Advanced Driver Assistance Systems** (ADAS) technology is often the starting point for autonomous capabilities, ADAS and autonomous are often mentioned in the same breath. ADAS systems give the car better eyes and ears to understand its surroundings through advanced sensors like LIDAR, cameras, or ultrasonic microphones. Sensor fusion — the merging together of ADAS sensors to provide a holistic view of the environment around the car — is seen by most to be a basic requirement for input to a self-driving decision-making computer.

### Sensor fusion model required

Sensor fusion requires a completely new vehicle architecture. Rather than the current practice of adding individual features like lane departure or blind spot detection as individually sourced and supplied black boxes, a sensor fusion model as required by autonomous drive considers the vehicle as an interoperating whole.

> Suppliers who want to help OEMs in this transformation need to respect the fact that OEMs are not used to giving up control.

To handle this requires a significant transformation in the way automakers have traditionally designed, sourced, and built vehicles — perhaps the biggest change since the creation of tier-one suppliers in the latter part of the last century. Suppliers who want to help OEMs make this transformation need to respect the fact that OEMs are not used to giving up control. Perhaps the best way to help automakers develop a holistic vehicle architecture might be to do a joint venture separate from the main product line where failures won't significantly impact the OEM's bread and butter business.

## ACES | Connectivity

### Connectivity options

Five years ago, the decision on how to bring connectivity to the car was still an open question: either built-in using the car's own dedicated cellular connection, the model championed by GM OnStar, or the brought-in alternative used by Ford and others, linking the car to the consumer's smart phone. Since that time, the question has been settled — both are required, and both are part of nearly every automaker's lineup.

### Need for both built-in and brought-in

A dedicated connection is needed for vehicle-centric services like cloud-based data and insurance, traffic and navigation solutions, cellular V2X, predictive maintenance, and software updates — services that automakers can monetize while creating distinctive offerings. But the smartphone connection brings necessary personalization to the car, with the user's preferred apps, music, news, location, and streaming services.

Therefore as a tier-one or tier-two connectivity provider, you'll need to support a built-in connection, provide a backend service if the OEM doesn't have one (or link to their service if they have one), and ensure that your system integrates well with Apple CarPlay and Android Auto.

### CONNECTED CAR HISTORY

| GEN | TECHNOLOGY | YEAR RELEASED | FIRST KNOWN USE IN PRODUCTION | MODEL YEAR |
|-----|-----------|---------------|-------------------------------|------------|
| 1G | AMPS | 1981 | **Cadillac (OnStar)** | 1996 |
| 2.5G | GPRS | 2000 | Volvo (WirelessCar)‡ | 2004 |
| 2.5G | CDMA 1xRTT | 1999 | **OnStar** | 2006 |
| 3G | W-CDMA | 2001 | Mercedes (Hughes)‡ | 2009 |
| 3G | HSPA+ | 2008 | **Audi** | 2012 |
| 4G | LTE | 2009 | **Audi** | 2015 |
| 4G | WiMAX2 | 2011 | Not in production | n/a |
| 5G | 5G-NR | 2018 | **BMW*** | 2021* |

* Based on announced 5G timelines
† Verified by executive at WirelessCar
‡ Through Blackberry smartphone

**The timeline between a new release of cellular technology and automaker deployment is expected to shrink as cars increasingly depend on connectivity.**

Tesla has made software updates a growing expectation for new car buyers by continually introducing new customer experiences, rather than using OTA as just a bug fix mechanism.

### Growing need for OTA

Over-the-air (OTA) updates were once viewed in the industry primarily as a way to avoid software recalls. Today, there is an overwhelming realization that updatable vehicle software is a necessity rather than a nice-to-have. One factor driving this realization is cybersecurity management which necessitates immediate updates to mitigate software vulnerabilities and is something that can never actually be "finished".

### Ongoing capability improvements

The need for OTA is also driven by emergent software-driven technologies like self-driving algorithms that continue to improve in performance and eliminate boundary limitations as the machine learning algorithms accumulate more data. Standard automaker practice has avoided using OTA to introduce new vehicle features, in part driven by restrictive dealer covenants that discourage or actively prohibit OEMs from potentially cannibalizing dealership sales.

## HIGHLIGHTS OF TESLA SOFTWARE UPDATE PROGRAM

| | |
|---|---|
| **October 2012** | Supercharging, driver profile, creep mode, improved map |
| **December 2012** | Voice commands, sleep mode, USB music playback |
| **July 2013** | Flexible charging units, improved defrost functions, phone contact list |
| **November 2013** | Vampire killer, tow mode, personalization improvements |
| **September 2014** | Traffic-based navigation, location-based suspension, Bluetooth calendar sync |
| **January 2015** | Traffic-aware cruise control, forward collision warning, trip energy predictor |
| **Spring 2015** | Range alert, auto emergency braking, blind-spot warning |
| **October 2015** | Autosteer, Autopark, automatic lane changes, blind-spot monitors |
| **January 2016** | Summon feature, perpendicular autopark |
| **September 2017** | Natural voice improvements, map improvements |
| **March 2017** | Adaptive cruise control, auto lane change, automatic high beams, speed assist |
| **February 2018** | Unlock doors through smartphone |
| **April 2018** | Automatic high beams |
| **September 2019** | Tesla Theater, Spotify, Caraoke, Driving Visualization |
| **November 2019** | Stopping Mode, scheduled departure and charging feature |

### Ability to introduce new features

However, Tesla, with its lack of dealerships and accompanying binding restrictions, has made introducing new features to existing vehicles novel, exciting, and widely acclaimed. Public awareness of the power of OTA to improve existing vehicle assets and the resulting public pressure will become a third critical OTA enabler.

Once OEMs have the freedom to update their cars, they could (and should) use that capability to create continuous customer engagement. Vehicles will soon join the rest of the IoT in using feature updates to keep customers loyal with perpetual user experiences that delight.

**Improving customer connections**

Connectivity across entire vehicle line-ups allows automakers to create cloud-based services that can drive revenue and improve customer experience (CX). To date, many of the cloud offerings on the CX side have been extensions of existing OEM platforms that remain unimaginative and underutilized.

Expect this situation to improve as automakers hunt for acquisition targets and technology partners that can bring life to their customer connections.

**The rise of privacy concerns**

The use of individual car-collected data promises a wide assortment of services and potential revenue streams for the OEM. However, it is also under some scrutiny from within the industry — automakers do not want the negative associations that have come with high-profile cases of private data abuse of late.

Data ownership is also an unknown with every party in the data food chain claiming some amount of ownership over the data they collect, transmit, or analyze. The end user too has a voice in this conversation, as **European mandates such as GDPR**, **California's CCPA**, and other similar government initiatives attempt to give the individual control over the data collected on them and rights over it.

> Data ownership is still an unknown with every party in the data food chain claiming some amount of ownership over the data they produce, collect, transmit, or analyze.

Protecting data access, maintaining user privacy, and ensuring anonymity often defeat wild-eyed visions of extracting perceived riches from the data mines.

**OTA: the automaker's most essential sales tool**

Whether paid by the automaker or the consumer, there's no denying that adding connectivity to the car comes at a cost. This has been a big factor in the OEM response for the last decade, with them delaying or side-stepping universal connectivity. However, if Tesla has shown us anything, it's that treating OTA can be a powerful tool that connects automakers to their customers and builds rabidly loyal brand fans. OEMs that aren't factoring ubiquitous built-in connectivity are missing a tremendous opportunity, and those that believe that it is a customer up-sell option are doomed to be left behind.

## ACES | Electrification

It's most definitely simpler to build an electric motor than an engine powered by gasoline; even children can build a rudimentary one out of copper wire, nails, and a 9V battery. That apparent simplicity has dramatically lessened the requirements for new companies to enter the transportation market, as they now don't have to solve the many challenges of isolating a motor from the explosively flammable liquid it depends on. The benefits of electrification aren't just the simplicity of manufacture but a dramatic decrease in maintenance.



**Strong and increasing electric sales for the last several years may be an indicator that we're leaving the early adopter phase and entering the early majority part of the EV adoption curve.**

With all the positives, there are still significant challenges to overcome. As mentioned before, whether using electric engines or not, any new mobility provider still must create a reproducible and quality product at scale. They have to convince the public that range anxiety is something easy to work around and get fully electric vehicles to be seen as a choice that's non-remarkable as a practical alternative. They must help deploy infrastructure that supports recharging stations and develop cross-industry standards. They need to develop battery technology that recharges effectively over time and under cold conditions, and makes good use of existing natural resources. And finally, they have to compete against negative publicity, incentive cancellations, and additional regulations being drummed up by a severely threatened and massively powerful **oil industry**.

Automakers have been very tepid in their response about electric vehicles. It initially seems like a chicken-and-egg problem: without EV infrastructure consumers won't buy, without consumer demand OEMs won't build cars, without cars there's no incentive to build EV infrastructure. However, resistance to EVs is also the corporate response to a radical rethinking of their product space. GM has had EV technology since the much vaunted EV1 — over 24 years ago. But traditional OEMs are too risk adverse to wholesale gamble on the sea of change that electric will bring.

## Electric gamblers

This is why the real movers and shakers in EV have come from outside. Tesla and a spawn of similarly inspired OEM ventures — including Faraday Future, Byton, Nio, Lucid Motors, Karma, and Rivian — are able to dream big because they're unsaddled with the baggage of legacy systems. But while electric concept cars may be compelling, most of these companies still need to live through the pain of productizing at scale, a lesson that Tesla has struggled with in bringing the Model 3 to market.

A mix of OEM knowledge and funding with new-OEM energy and creativity may be what it takes to drag the automakers into an EV era — with vision and profitability. Ford got it right by investing in Rivian to the tune of $500 million. This allows Ford to see what the market for a newly envisioned electric truck really is before it gambles too heavily on modifications that might cannibalize its top producing F-150 model line. By investing in a potential competitor rather than feeling out the market by watching Rivian's success, they have the ability to protect their best-selling segment. If Rivian really takes off, Ford can buy up a successful EV product to add to their lineup without having suffered the blood, sweat, and tears of getting it off the ground.

## Will the public buy?

Regardless of who is offering what, the question comes back to whether there's a market for electric vehicles or not. Data from **InsideEVs** shows a trend of continually escalating EV purchases over the last eight years, with Tesla leading the charge. This is proof positive that the EV market is shedding some of its sponginess and becoming more solid.



**Rivian was the first to attack the electric truck sub-segment, something that standard OEMs have been too reticent to do.** Image: Third Law.

2019 was also the year when **climate change awareness** broke into the mainstream, fueled by record breaking temperatures, droughts and wildfires, and teenage activists. That public awareness and desire to "do something", combined with the relentless expansion of EV infrastructure by companies like EvGo, ChargePoint, Electrify America, and Tesla means that the EV market is more ripe than ever before.

## WORLDWIDE ELECTRIC VEHICLE SALES
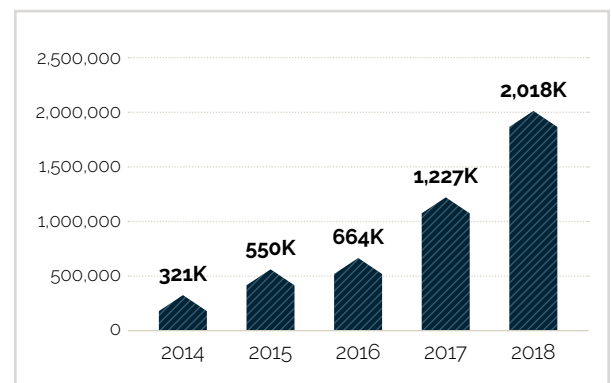


**The popularity of EVs has continued to grow and, given today's climate change awareness, is likely to escalate.** Chart data: **InsideEVs**.

The manufacturing industry may get commoditized by the services industry through such initiatives as ridesharing and carsharing.

## ACES | Sharing

Owning your first car isn't the rite of passage it used to be — simply because it is no longer a necessity. In North America at least, avoiding car ownership was once something reserved for the occupants of very big cities with even bigger parking problems.

However, Uber, Lyft, and the ecosystem of similar companies they've sparked into life have brought all new forms of transportation to all but rural and remote locations. Those options include ride hailing, ride sharing, car sharing, partial ownership, private lending, and multi-modal mobility, as well as niche variants by passenger type (such as women driving other women, or mothers driving children) and vehicle type (sports car, RV, Teslas, and so on).

While non-ownership has not yet made a measurable impact on expected sales volumes, OEMs are buffering themselves from a potential drop in sales by exploring one of the many mobility as a service (MaaS) variants. Through spinoffs, acquisitions, and partnerships, OEM teams (such as GM and Maven, BMW and ReachNow) are attempting to establish footholds in both the product and service components of transportation — although many of these initiatives are fraught with birthing pains or are short-lived. The ramping up of any service-related mobility business comes with the recognition that any increase in ride sharing may also cannibalize future sales potential; it's better to eat one's own lunch rather than hand it off to an upstart.

## AUTOMAKER BETS IN THE SHARING ECONOMY

| | INVESTMENTS | ACQUISITIONS | PARTNERSHIPS | SPINOFFS & PILOTS |
|---|---|---|---|---|
| **VW** | Gett ($300m) | | | Moia, WeShare |
| **Toyota** | Uber ($500m), Grab ($1b) | | Getaround, JapanTaxi | |
| **GM** | Lyft ($500m), Yi Wei Xing (undisclosed) | Sidecar* | | Maven |
| **Ford** | | | | GoDrive*, Ford Smart Mobility |
| **Daimler** | | mytaxi, RideScout | Turo | car2go, moovel*, Croove, Daimler Mobility Services, REACH NOW, Daimler+Geely JV‡ |
| **Honda** | Reachda ($9m), Flexcar (undisclosed) | | Reachstar, Zipcar, Grab | EveryGo |
| **Hyundai** | Revv ($14.3m), Car Next Door ($6.2m) | | | Hyundai Mobility Lab |
| **BMW** | Scoop | | | BMW ReachNow*, REACH NOW |
| **Geely** | CaoCao | | | Daimler+Geely JV‡ |
| **FCA** | | | Waymo, Turo | |

\* Casualty of merger or otherwise no longer in business
‡ As yet unnamed

**The number of automaker investments, acquisitions, partnerships, and spinoffs in sharing ventures illustrate the OEM desire to capture part of the Uber/Lyft excitement.**

Ride sharing also will have an impact on the future of car design. As cars are increasingly built for multiple owners or riders, personalization features that track the driver rather than the car will become more common, as well as features designed to help improve the user experience of ride-sharing or car-sharing, similar to aftermarket retro-fits for taxis although hopefully more passenger-centric in design.

> As cars are increasingly built for multiple owners or riders, personalization features that track the driver rather than the car will become more common.

## THE SHIFT FROM PERSONAL TO FLEET OWNERSHIP WILL CREATE YET ONE MORE PRESSURE ON THE ALREADY FRAGILE DEALER ECOSYSTEM.

**Taxis are under pressure from car- and ride-sharing services; if the industry can last long enough to survive, it may be able to stage a comeback with autonomous fleets.**

Taxi services, with their fleets of identical poorly appointed offerings, will be less able to effectively compete with car-sharing endeavors. As cars become less individually owned, taxis may be marginalized. However, the taxi-fleet purchasing model may become common, leading to large numbers of autonomous vehicles purchased by fledgling MaaS providers.

Not just taxi drivers and taxi companies will be negatively affected by this move — the shift from personal to fleet ownership will create yet one more pressure on the already fragile dealer ecosystem. With less need to showcase and sell vehicles to the public and more corporate-level volume purchases, automakers will reduce the massive spends they currently make to attract the everyday consumer, starting with dealerships. ◼

# IN-VEHICLE INFOTAINMENT

## Passing on the technology baton

As the infotainment system has become widely accepted and valued by consumers, it is now an expected portal into the vehicle. Against the backdrop of self-driving cars, infotainment doesn't have the same "shiny new feel" it once did, but there is still quite a bit of interest and forward progress in this space, especially as infotainment is the user-visible data portal to the car. The big question is: will OEM infotainment systems remain relevant?

## Who owns the customer?

Automakers originally wanted to bring Apple CarPlay and Google's Android Auto into the car in an effort to combat the prevailing view that their cars were technologically dated and behind the times. This "deal with the devil" meant a loss in the battle for data ownership and customer mind share, which they attempted to mitigate by creating their own differentiated infotainment offerings and app stores.

The automakers have fundamentally lost this battle — smartphone brands are now more relevant and more desirable in the car to most consumers than the automaker's own offering. The smartphone integration point will always be a thorn in the side of automakers as it requires engineering vehicles to include features largely outside their control, it underscores the life-expectancy discrepancy between consumer electronics and cars, it introduces cybersecurity risks to a much greater population of vehicles, and it means a lack of business control over the use and value of the vehicle's data. By inviting the smartphone into the car, automakers have ceded personalization options, navigation, entertainment, and their fledgling app stores to a competitive force that's impossible-to-match in the consumer's mind. It also introduces a fight for the car's data — something easily monetized by Silicon Valley yet still a challenge for the OEMs. We expect a consumer electronics bridge will be a part of automotive solutions for the foreseeable future.



**Automakers have lost the built-in versus brought-in fight, with most consumers preferring smartphone brands to automaker offerings.**

## From infotainment to entertainment

The need for future consumer electronics in the vehicle becomes especially true for self-driving cars. As the driver is freed from the "eyes on the road" mantra, they'll be available for a digital morphine drip in offerings from Disney, Netflix, and Amazon. A move from infotainment to entertainment also means more and larger display surfaces and full-glass cockpits with greater freedom in content, format, and presentation. OEMs may not be controlling the media brought into the car, but they'll get a chance to exercise their deep design chops on full interior displays, providing plenty of opportunity for innovation and differentiation. ◼

# SOFTWARE AND THE VEHICLE

## Automakers are still coming to grips with the reality

It's often been said that the modern car now depends on **hundreds of millions of lines of code** — several times more than a Boeing 787. What often goes unsaid is that this software dependency requires a fundamental shift in the automaker's core business model — a shift that's barely recognized and certainly not yet embraced. Can a "piston and powertrain" company ever adopt a "software first" approach to their business?

## OEM SUPPLY CHAIN



OEMs:
**43**

Tier ones:
**400**

Tier twos:
**50,000**
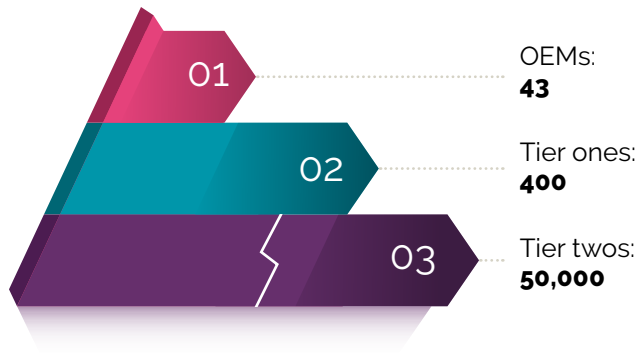
**The auto ecosystem is structured with the OEM at the top of the food chain, but this structure is threatened by new mobility companies coming from outside automotive who think differently.** Sources: OICA, Marklines



**Software updates should include fixes as well as features; automakers will have to negotiate with dealers to lift restrictive update policies to make this successful.**

## OEM-supplier model

The automotive supplier model — with OEMs specifying module content and tier-one suppliers building it — has been in place for decades, long before software became a critical core competency. As a result, the automakers have outsourced the vast majority of their software competency to others. The OEM's lack of inherent understanding of the importance of software combined with a traditionally mechanical and hardware-based mindset leads to organizational

blindness about the impacts of software: its benefits, dangers, opportunities, and methods. OEMs simply do not consider any aspect of the car from a software first point-of-view — a primary drawback often voiced by Silicon Valley critics — which leaves them exceedingly vulnerable to irrelevancy in the new world order.

A lack of sufficient OEM software engineering depth in the short term leads to requirements that are overly specified, exceedingly complicated, and already obsolete, as well as inappropriately informed decisions about the technical content underlying proposed supplier solutions. To help OEMs shoulder the load of building cars with quickly changing technology, tier ones need to become specialized experts in many areas of autotech competency and be willing to share their knowledge with the OEM to become trusted advisors.

> A lack of sufficient OEM software engineering depth in the short term leads to requirements that are overly specified, exceedingly complicated, and already obsolete.

## REQUISITE CHANGES TO THE OEM BUSINESS MODEL

- **CREATE** a code base that can share software between intra-vehicle modules, different vehicle lines, successive model years, and competitive suppliers

- **TORPEDO** the rigid walls of the purchasing process to include non-traditional third-party software suppliers and to develop car software hand-in-hand through larger, dynamic software communities

- **DEVELOP** software that derives speed from agile methodologies and breadth through a rich open source community that can continue to release software in vehicles designed for updatability and temper these new additions with ISO26262 and functional safety processes

- **BUILD** an in-house software competency that can consistently and periodically roll out updates for cybersecurity issues, bug fixes, and new features to the subset of vehicles that require them

- **LET GO** of validation procedures that cannot adapt to the new reality of software updates and adopt newer methods of continuous integration

- **MOVE** from proprietary in-vehicle networks to Internet-age standards for in-vehicle communication, encryption, and authentication

- **EDUCATE** the OEM C-suite on fundamental software literacy so they can make critical planning decisions as if the car were primarily an IoT asset rather than a mechanical one

## Software ownership requires a culture shift

Far more troublesome is the long-range problem that inadequate software competency introduces: the automaker's inability to develop vehicle software holistically. To address this, it would mean owning the software for the entire car and evolving it as features are added or bugs are fixed. This would involve some serious changes to the OEM business model.

## Embracing software

While every one of these items is in the exploratory realm of many automakers, embracing the entire picture is extraordinarily difficult. This is also why Tesla is such a threat (even considering their volume production woes) because they do get software. Embracing software literacy at all levels would require an organizational transformation far too radical and risky for all but the most daring and nimble automaker. The next best alternative has been rumoured for years although yet to be fully seen: an automaker and software giant each bringing their respective expertise to bear in a new joint venture.

> Shifting OEM culture to be software-first may not be possible without hitting reset on the organization.

Deep software competency is necessary to succeed in the new world of mobility. Arguably, shifting an OEM culture to be software-first may not be possible without hitting reset on the organization. An automaker's greatest fear is that that they might be fundamentally incapable of the transformation needed to stave off impending irrelevancy. Rather than believe that they will be the next marginalized giant, most of the auto industry keeps their head firmly in the sand, believing that software startup investments and incremental technology changes will shore up their software capability, even though in their heart of hearts they know it won't affect the ultimate trajectory.

## The value of data

The car is shifting from an owned asset to a digital portal and advertising platform. With this shift, its value gets transferred from car manufacturers to data aggregators and content creators. The automaker's role in new mobility is becoming commoditized.

> As the car shifts from an owned asset to a digital portal and advertising platform, its value gets transferred from car manufacturers to data aggregators and content creators.

Because physical machine construction requires a huge infrastructure and expensive materials, the best OEMs can hope for is to continue to eke out comparably low profit margins. Contrast this with the cloud providers such as Amazon, Facebook, Google, Netflix, Disney, and others, most of whom — if not already actively entrenching themselves in the space — are poised to take full advantage of the vehicle data stream.

**Big data is not a new concept but applying it to vehicles is.**

**THE COMPANIES WHOSE LIFEBLOOD IS DATA ARE THE ONES WHO WILL UNDERSTAND HOW TO USE IT AND WILL WALK AWAY WITH THE LION'S SHARE OF NEW MOBILITY PROFIT, CONTROL OF THE BUSINESS DYNAMIC, AND CONSUMER'S BRAND PREFERENCES.**



**Apple collects data while customers appreciate a well-known interface.**

Digesting tons of personalized vehicle data will let the data aggregators create additional car-derived value, in the same way they do now with our web browsers and smartphones. With an understanding of our behaviours and habits, these consumer giants will be able to serve up perfectly targeted marketing timed to our purchase vulnerabilities, exactly when we drive by their advertiser's stores. The car's transformation into a self-driving media consumption bubble will give similar power to social media platforms as well as video and audio streaming providers, who can keep us actively consuming their media and advertising while we journey from place to place.

OEMs have long fought to "keep the car's data" in any arrangements with Google or Microsoft, understanding that the data is valuable but misunderstanding how to capitalize on it. The companies whose lifeblood is data are the ones who will understand how to use it, and will walk away with the lion's share of new mobility profit, control of the business dynamic, and consumer's brand preferences. ◼

# CYBERSECURITY

## What automakers really fear. Hint: it's not a hack

Before Miller and Valasek's **infamous Jeep hack** in 2015, 95 percent of industry pundits refused to believe that cars could be remotely hacked in any serious way. Thanks to Charlie, Chris, and many others, the automotive industry now knows that the majority of our cybersecurity measures are woefully inadequate and our requirements force suppliers to pick between robust cybersecurity and competitive cost. Why is the industry is not moving as fast as it should?

**Automotive needs to leave the hubris behind that cars are magically different and therefore don't need the same level of cybersecurity as products in other markets.**

## Cybersecurity driven by cost will fail

Cybersecurity is but one aspect of modern software creation, albeit a highly complex and multi-faceted one. Automakers have done an admirable job of recruiting and training talent that understands the challenges of cybersecurity. That said, OEMs still value lower BOM pricing over better cybersecurity, a situation that is unlikely to change without a major tragedy.

Government involvement may drive cybersecurity advancements sooner than automaker's own initiatives — unless an industry-wide "hackmageddon" spurs sooner action. Timelines for comprehensively deployed automotive cybersecurity are not rapid in either case. OEMs generally fear that industry standards and regulations stifle innovation and quell differentiation, and so they are never eager

to work closely with their competition. Thankfully though, automakers see the potential damage to the entire community exposed by cybersecurity vulnerabilities and have been unusually eager to cooperate with their peers in cross-industry cybersecurity measures like AutoISAC.

> OEMs generally fear that industry standards and regulations stifle innovation and quell differentiation.

**Cybersecurity attacks are dramatically escalating, the majority of them remote. A wide-spread cyber-disaster is an unfortunate inevitability, and automakers need to put the pedal to the metal.** Image: **Upstream Security**.

## Slow adoption of cybersecurity solutions

It's not as if there aren't a ton of cybersecurity companies willing to help the automakers. Other than the previously mentioned automaker priorities and internal decision making, three other factors contribute to a slow adoption of cybersecurity solutions into automotive products.

- **ARCHITECTURE.** A standard vehicle's software architecture is byzantine, sprawling across hundreds of separately specified, coded, and delivered modules, a wide spectrum of processors and capabilities, and multiple suppliers. Finding a solution that works equally well on all is impossible — so a high degree of fine-tuning will be required to adopt any one technology that requires consistent application.

- **COMPLEXITY.** Cybersecurity is not a "one size fits all" product. In fact, it consists of many different subdomains that treat different areas of the problem, each with many companies vying for attention. One cybersecurity product or company will never be fully sufficient. For the automaker to understand exactly which combination of technologies is required for base level coverage is far from a simple problem. This is especially difficult given the speed of evolution in the cybersecurity cat-and-mouse game, as hacker techniques rapidly evolve to evade detection.

- **DOMAIN.** Most cybersecurity companies bring their technology from other industries, and while they may have application within automotive there is rarely a perfect fit. Cybersecurity vendors need to understand and adapt to the automotive mindset and processes. Their lack of having an innate automotive understanding can be a roadblock for automotive customers who don't want a supplier's automotive education (and expensive mistakes) to be learned on their dime. ◼

# V2X AND SMART CITIES

## The breakthrough that may just make all this possible

Vehicle to vehicle (V2V), vehicle to infrastructure (V2I), vehicle to pedestrian (V2P), and their combination, vehicle to everything (V2X) are technologies that allow cars to exchange information with their environment. Their fundamental goal is improving vehicle safety. What are the chances we can commit ourselves to making an integrated cross-industry solution actually work?

**OEMS HAVE LITTLE INCENTIVE TO INTRODUCE NEW V2X TECHNOLOGIES THAT ARE OEM-SPECIFIC, INCREASE PRICES, OR ADD REQUIREMENTS.**

## The long and winding V2X road

V2X technologies have been under investigation at least since the early 2000s by OEM R&D departments and academia, and can in fact increase the margin of passenger safety. But as a whole V2X has made about as much progress out of the lab as you'd expect from something that requires perfect cross-competitor collaboration and government-led innovation. Which is to say — from the viewpoint of the driving public — practically none.

This shouldn't be too much of a surprise: changes to technology are blindingly fast compared to drafting new regulations. DSRC-based proposals are obsolete before they've gained sufficient industry traction. And OEMs have little incentive to introduce new V2X technologies that only work within their fleet, that increase price to consumers with no immediate gain, or that burden their vehicles with additional compliance requirements for both standards and regulations.

Some expect V2X will become widespread with the rise of autonomous cars. This is because of the perceived need for self-driving vehicles to gain as much information as possible about the road network and the vehicles around it. However autonomous cars will need to function in places where V2I networks don't exist or neighboring cars aren't V2V equipped. V2X may improve the information available to a driving computer and can help handle specific use cases — such as traffic circles or stop lights — but aren't a base enabling technology for autonomous.

**Vehicles could end up beating infrastructure in terms of V2X standardization.**
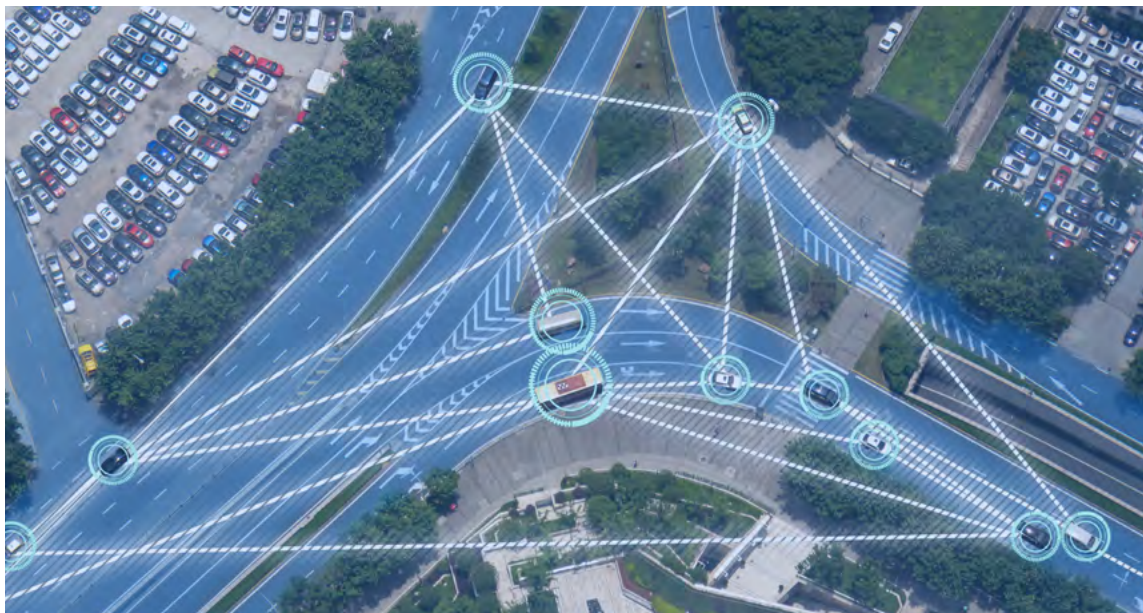
## Will CV2X save V2X?

CV2X (or cellular V2X) is the most promising development in V2X in decades. All cars are becoming connected as well as having the requisite cellular radio. With the CV2X standard currently offered by Qualcomm, the cellular industry's defacto chip monopoly, the odds of having multiple cars from multiple vendors that can speak to each other as well as to a road or city network has risen exponentially. Qualcomm's CV2X offering may well be the breakthrough that V2X finally needs to become ubiquitous.

The V2I portion of smart city infrastructure projects promises us urban streets, parking spaces, and traffic lights all intelligently wired to the city's grid and communicating with the cars roaming its roads. The ultimate goal of this smart city V2I dialog is several-fold: alleviating congestion, allowing more human-centric developments, improving pedestrian and

> With the introduction of Qualcomm's CV2X, the odds of having multiple cars from multiple vendors speak to each other along with the necessary infrastructure has risen exponentially.

bicyclist safety, mitigating traffic in emergencies, and avoiding collisions. It may also offer us better options in multi-modal transportation, as cars can negotiate their passenger's ride with public services. Many test beds for car-enabled smart cities exist as these options are tested out. ◼

# THE NOT-SO DISTANT FUTURE

How big data, AI, and machine learning will affect us all

The fever pitch around big data within automotive has been growing for nearly a decade due to its monetization possibilities. With the introduction of autonomous cars, people will be seen as data-generators and sources of on-going revenue rather than purchasers. Meanwhile, AIs continue to get smarter and more capable, leaving us with less to do. Where does this leave automotive? Where does this leave us?

## Monetization of the customer experience

One main factor increasing interest in big data within automotive is the monetization of the customer experience. By mining customer data for purchaser trends, vehicle platforms stand to offer individually tailored advertising at a premium to advertisers. This will allow marketers to target a mobile audience with pin-point accuracy, much like Google, Amazon, and Apple do now. Fancying a driver/passenger as primarily a product-consuming engine leads to speculation such as John Ellis' **Zero Dollar Car**, where the value of the vehicle may become completely subsidized by the advertisers wanting to get access to a captive audience. Whether through a zero-dollar car or a mobile-phone model where a monthly mobility subscription partially subsidizes one's vehicle, it's certain that there are cautionary lessons here of vehicle commoditization.

Another factor pushing massive automotive data collection is the self-driving car. Machine learning provides the best-known means of developing the computer vision algorithms necessary for piloting autonomous vehicles. Machine learning algorithms are adapted by feeding them millions of training examples. For sensors such as cameras, LIDAR, radar, or ultrasound, the training data is thousands of hours of video and/or images. Machine learning techniques are also being focused on driving control systems, safety predictive systems, and many other areas that self-driving requires.

Machine learning provides the best-known means of developing the computer vision algorithms necessary for piloting autonomous vehicles.

Both autonomous driving and customer monetization are facets of artificial intelligence, a moniker that encapsulates many hundreds of mathematical techniques from statistics to neural nets to give machines a semblance of intelligence. Automotive AI manifests itself in not only autonomous driving and advertiser targeting as discussed, but speech recognition, traffic routing, navigation planning, predictive diagnostics, driver education, fleet platooning, driver monitoring, robotic manufacturing and assembly, and ride sharing. AI provides the power to automate tasks, and this automation will continue to have an impact on jobs. While manufacturing has already felt the brunt of automation, we have yet as a society to understand the full impact of self-driving as it makes people who make a living from driving redundant, such as truckers, bus drivers, and taxi drivers.
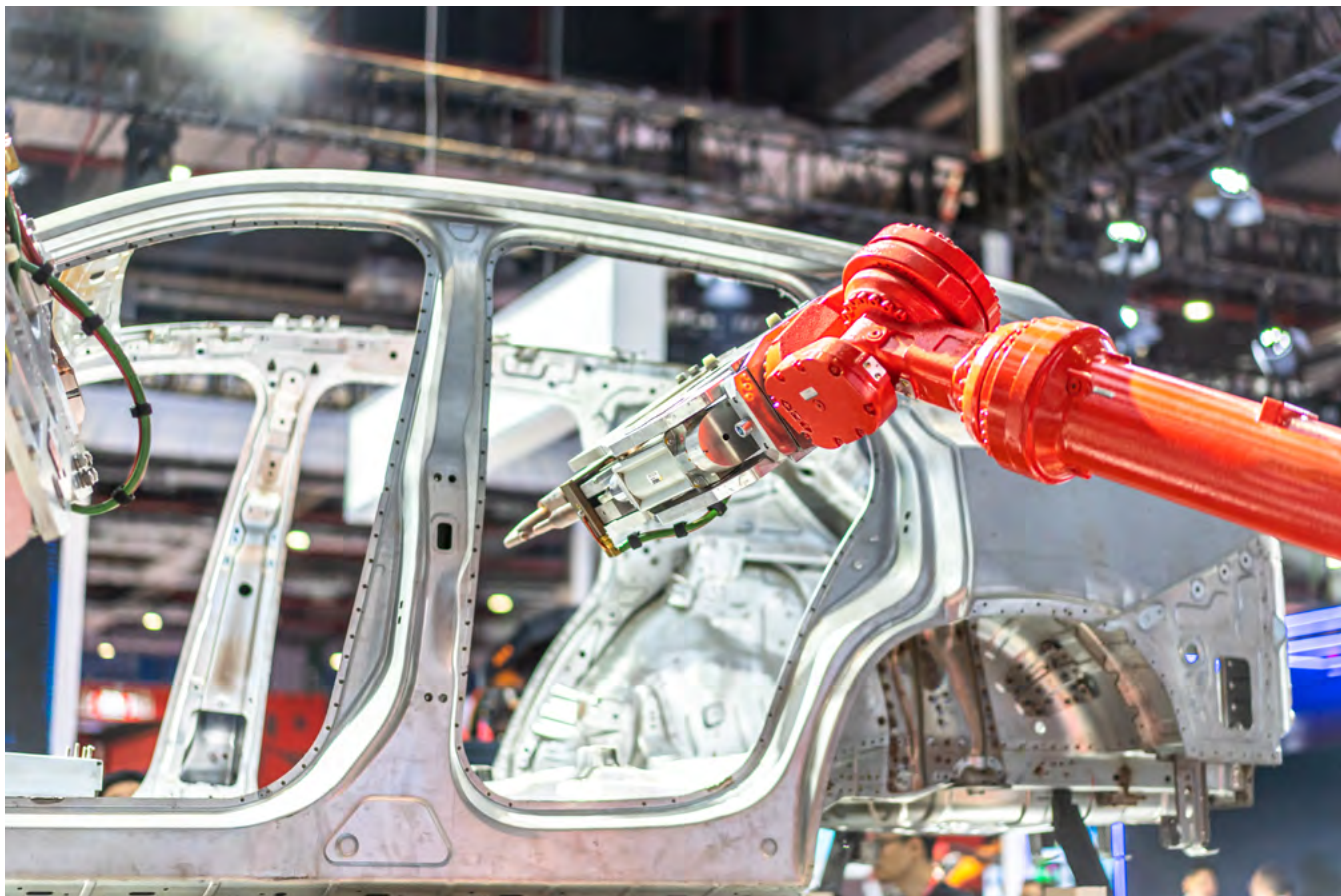
**Automotive has long embraced robots on the assembly line — will the public be as willing to accept them in the driver's seat?**

## The short road from gaming to driving

Somewhat unexpectedly, the actual possibility of a car driving itself is wholly due to video games. The never-ending pursuit for more realistically rendered scenes has pushed graphics processors to become faster and faster, with higher resolutions, faster frame rates, and continually improving physics-based lighting calculations. Light years away from yesteryear's VGA, today's graphical processing units (GPUs) can calculate many millions of operations in parallel to display smooth, full-screen, fully rendered screens. With very slight adaptations, these chips that excel at making realistic first-person shooters can be transformed into massively parallel processing engines, necessary to make short work of computer vision and other machine learning problems. This is why the "gaming" company Nvidia is now such a key supplier in the automotive space.

> Somewhat unexpectedly, the actual possibility of a self-driving car is due in no small part to video games.

**AI drivers can be regularly downloaded with improvements from lessons learned on the road.**

As Waymo, Uber, Cruise, Baidu, Intel, Tesla and the OEMs continue to rack up self-driven mileage, they chip away at the superiority of human drivers.

## Shared smarts

The value of AI in an automotive context is not just the ability to train machines to do human tasks — it's also in the ability to share the data of driving. As self-driving cars continue to log miles and video on our roads, they will be constantly collecting new data, finding unique failure modes and giving the manufacturer the ability to correct driving mistakes encountered on the road. AIs can be retrained to incorporate new data, which can be subsequently downloaded to every car across the fleet. Unlike humans, when one AI crashes, they will all learn from that one mistake. This incredible capability of sharing smarts makes the high bar of Vision Zero — no automotive fatalities — seem within reach.

The simplicity in changing, updating, and replicating an AI makes them a tool that can become superior to a human in every way. AIs won't fall asleep while driving, and they will never be distracted by phones or back-seat banter, eliminating those categories of driver accidents. That's not to say that AIs will be perfect. They will introduce new errors into the driving equation, causing accidents for reasons that humans never would, like failing to spot a white truck crossing the vehicle's path. However, unlike us, they can be fixed and reloaded with new "brains" every time they fail. As Waymo, Uber, Cruise, Baidu, Intel, Tesla and the OEMs continue to rack up self-driven mileage, they chip away at the superiority of human drivers. While many in the public feel uncomfortable with letting a car drive, it's something that one becomes accustomed to surprisingly quickly. There's little doubt that we will all feel safe and secure when the AIs inevitably become our chauffeurs. The power of machine learning and artificial intelligence will eventually take over nearly every human task — but that's a subject for another book. ◼

# IN THE END
It's all about the customer

The automotive market is currently a most dynamic one. Everything is in flux: industry players, business models, and developing technologies. Automakers will need to be visionary and courageous to remake their products and business approach. OEMs have immense advantages that have been hard won over many decades of building large and complex products at high quality and large volume. However, to survive the disruption, automakers must embrace software as a primary driver of value to customers. Afterall, the customers will ultimately dictate the shape of the mobility market to come. ◼

## ABOUT THIRD LAW

Third Law is a boutique marketing agency focused on the automotive technology market. The company has first-hand knowledge of the complex autotech ecosystem, which allows them to bridge the gap between technology innovators and difficult-to-reach decision makers. They can digest highly complex automotive technology and translate its value in ways that resonate, influence, and drive engagement. Customers have included Abalta, Movimento, OpenCar (all since acquired) as well as the LA Auto Show, Mitsubishi Electric, The Qt Company, and more. Founded in 2014 as CX3 Marketing, Third Law is based in Canada.

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