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What's the real value of the world's most powerful and efficient electric sedan?

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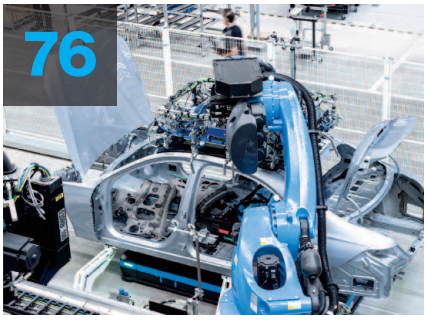

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What's the real value of the world's most powerful and efficient electric sedan?

Lucid Motors' CEO speaks to Megan Lampinen about the psychology behind the Air's 500+ mile range

Could one new model really kick-start the electric transport revolution? It might, if it offered a range of more than 500 miles and a 2.5-second sprint from 0 to 60mph with up to 1,080hp. Throw in some world-beating charging times, advanced sensor suites and high-resolution LiDAR and you get the potentially game changing Lucid Air. It will officially become the most powerful and most efficient all-electric sedan when it launches next year, but it comes at a cost. Prices start at about US$80,000 for the most basic trim level–which isn't even available until 2022–and run up to US$169,000 for the all-inclusive, limited-volume Air Dream Edition.

All about efficiency

Clearly the number of buyers for such a model will be limited. But the idea, according to Lucid's Chief Executive Officer Peter Rawlinson, is to apply the technological advancements pioneered in the Air to a more affordable range of models in the future: "The technology that we develop for the Air is suited for mass-production in more affordable cars. It's all about efficiency. This is the best single metric of an EV company's technology, even more significant than range. Anyone can create unintelligent range by just stuffing a whole lot of batteries in a car, having a product that weighs a ton. We need to chase down intelligent range through efficiency."

And the company boasting the highest efficiency right now, by a wide margin, is Lucid. It claims to be 15% ahead of Tesla today, and Tesla is "miles ahead of everyone else," adds Rawlinson, who also serves as Lucid's Chief Technology Officer. Notably, Rawlinson served as Chief Engineer on the Tesla Model S, and many of the patents around that car are in his name.

It's this efficiency that will allow Lucid to eventually reach a wider audience. As Rawlinson elaborates: "If we can make cars more efficient, we can go the same mileage with a smaller battery pack. Because the battery pack is the heaviest and most expensive thing in an electric car, that addresses the affordability and range issue with one stroke."

Lucid's roots are in battery technology, and in its original guise as Atieva it specialised in making EV batteries for automakers. The company emerged from a rebranding exercise in 2016 as Lucid Motors, officially confirming plans to develop its own high-performance luxury EV. The Air will mark its first vehicle but the company still supplies the batteries, distributed under McLaren, for all the vehicles competing in Formula E. "We're chasing down efficiency now to build a car with a range over 500 miles–admittedly an expensive car–but the real value of what we're doing today is to benefit the cars of tomorrow," Rawlinson tells *Automotive World*. "This exclusive product is

Customer deliveries of the Lucid Air begin in early 2021

> Range is the elephant in the room, the bogeyman, the last bastion of argument against electrification
>
> *Peter Rawlinson*
> *Lucid Motors*


© Lucid Motors

designed in a manner where it can cascade through to mass transportation of vehicles in the future."

A shock to the system

Rawlinson likens the current situation with EVs to that of the early gasoline cars, which began as the preserve of the rich. Only once it could be mass-produced did the motor vehicle become affordable, and only then could it mobilise the world. Part of the reason the Air carries such a hefty price tag is its 517-mile range, as estimated by the EPA. That range, though, may seem excessive, considering current estimates that 98% of journeys are less than 50 miles. Carrying the load of a battery that is sized to deliver up to 517 miles for short journeys could be seen as counter-productive.

But there's logic to this, promises Rawlinson: "Range is the elephant in the room, the bogeyman, the last bastion of argument against electrification. We need a shock to the system. We need to exorcise this evil spirit, as it were. The answer is to create an electric car which has more range than a gasoline car. I personally don't need a 500-mile range, most people don't, most of the time."

He has a couple of analogies, one of which is a deep sea diver's watch that can work at depths of up to 1,000 metres: "The human body can't even function at that depth, but everyone seems to need that high-end diver's watch." He also freely likens the Air's range capabilities to the Chelsea tractors—the Land Rovers popular among wealthy Londoners who never go off-road. "There's a very interesting psychology at play here. We are using efficiency to create a hammer blow riposte to those doubters about range."

Long-term antidote

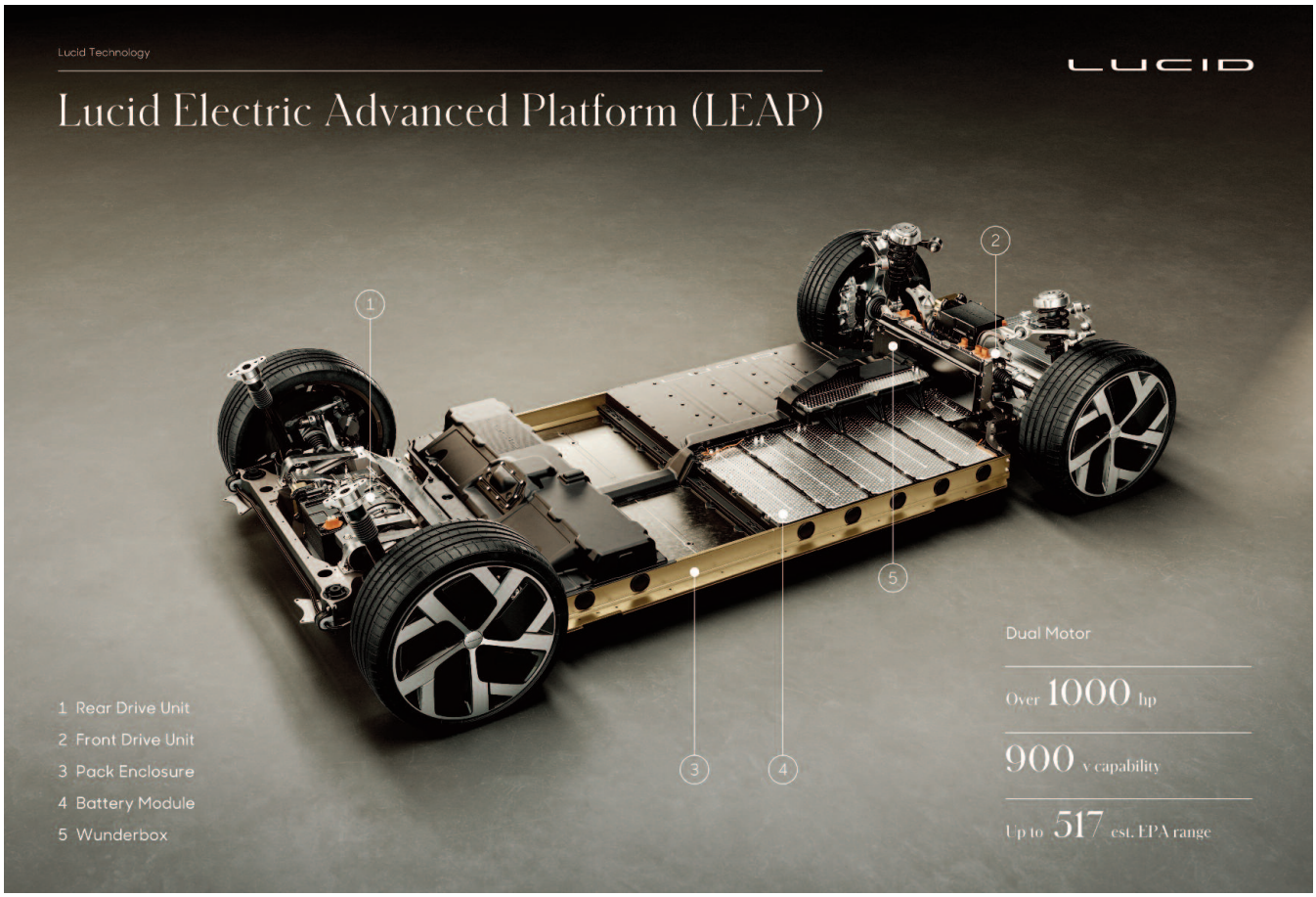
The long-term play is to encourage widespread EV uptake, and that will require a different tactic. "The antidote to range anxiety is no longer carrying the range on the car," he states. "I don't think there's a need for the next generation of electric cars to carry over 500 miles of range. They can be smaller. The technology we are developing at Lucid can apply to that new paradigm because it will require even smaller battery packs, and the cars could be lighter and more cost effective. And that cost-effectiveness, that barrier, will change the world."

This vision will demand much more public charging

infrastructure. When it comes to the 'chicken and the egg' dilemma around EVs and infrastructure, Rawlinson comes out in favour of EVs first. And he points to historical precedent: "Horses came first, then the stables. Gasoline cars came first, then the gas stations. You used to have to buy gasoline spirits in a demijohn from the chemist. There was no infrastructure. Now, we expect the fast-charging infrastructure to follow the advent of the electric car. Otherwise it's putting the cart before the horse."

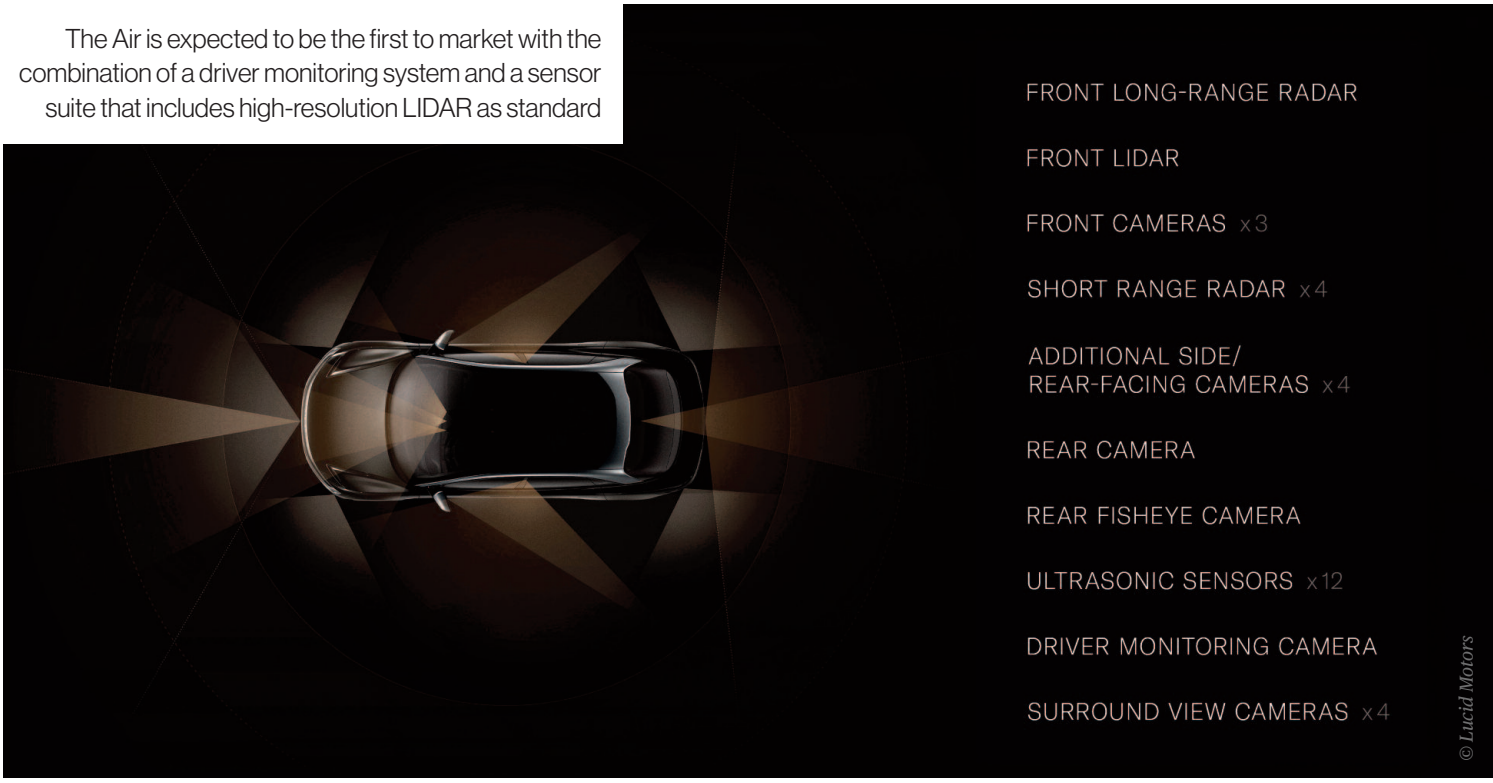
Autonomous driving outlook

There's more than just range on Lucid's radar. The company's mission is all about inspiring the adoption of sustainable transport. The way to do that, it believes, is by offering captivating EVs that focus on human experience. The DreamDrive is the company's advanced driver-assistance system (ADAS), which supports 19 different safety and driving features and boasts the most comprehensive sensor suite on the market with a cutting-edge driver monitoring system. "We are making the car as ready as it possibly can be for progressive levels of autonomous driving," explains Rawlinson. At the time of launch in spring 2021 it will offer SAE Level 2 capability. Over-the-air software updates should enable the jump to Level 3 within a few years. The Air doesn't feature sufficient hardware to take it to a full Level 4 autonomy, but elements of the platform are future proofed for this.



The Lucid Air has been independently verified by FEV to achieve an estimated EPA range of 517 miles

The Air is expected to be the first to market with the combination of a driver monitoring system and a sensor suite that includes high-resolution LIDAR as standard



That said, Rawlinson remains cautious in his outlook for autonomous driving: "I'm very bullish about the widespread adoption of electrification but I take a more nuanced view of autonomous driving and ADAS. The world has been wooed by the prospect of truly driverless cars. The predictions are woefully misguided and hopelessly optimistic. At the same time, the predictions for the explosive growth of electrification are pessimistic. Electric cars are going to explode on the scene in the next five years. Autonomous driving ain't coming any time soon."

Define the brand

As the new kid on an already crowded block, Lucid faces clear challenges. Industry watchers have speculated that it aims to take on Tesla, which at the moment dominates the EV segment in many markets. While Rawlinson recognises Tesla as the industry leader in terms of range and technology, he's aiming for a different niche: the big luxury brands which have little if any electric models on offer. Rawlinson specifically mentions the Mercedes-Benz S-Class, BMW 7 Series, Audi A8, Jaguar XJ and Lexus LS.

"They have one thing in common: they are all gasoline-powered. I'm not trying to compete with Tesla. Tesla is not true luxury, it's more premium," he clarifies. "I'm going after the luxury sedan market, which is worth US$100bn a year worldwide. It is dominated by Mercedes, Audi and BMW."

And with the Air, Lucid is certainly entering the market with a bang. That's by necessity: "What happens with new companies is that the first product defines the brand. The first Ferrari was a V12, which has become synonymous with the brand. Lexus' build and quality were defined by LS400. I can't come with mediocrity, because we're a new brand. We have to come with a technological tour de force. It has to be shocking, it has to be the best."


NIKOLA

Where does Trevor Milton end and Nikola begin?

What will Milton's departure mean for a company that was as much tied to its leader as its business plan? By Megan Lampinen

Trevor Milton founded Nikola Motor with the laudable aim of cleaning up emissions from the trucking sector. His passion and confidence in the company's vision–along with a strong social media presence and a propensity to post candid tweets–won over investors in much the same way Elon Musk has at Tesla. But Hindenburg Research's recent allegation that Milton made various false claims about the company's technology proved fatal, forcing the charismatic founder to make an abrupt departure. What will his absence mean for a company that was as much tied to its leader as its business plan?

© Nikola

Big on promise, short on product

Milton made his ambitions for Nikola clear from the start. Back in 2016 he was boasting: "We believe we will pass the current market leaders like Daimler, Paccar, Volvo and Navistar in sales orders within the next 12-24 months," and warning that "other OEMs and their shareholders ...should be nervous about Nikola Motor Company." But whilst heavy on promises, he was light on product, and even the concept for the product proved fluid. The first heavy truck model, the Nikola One, was originally put forward as an electric truck with a small range extender that could run on CNG in some markets, but would likely rely on gasoline or diesel in others. At some point that changed to hydrogen and Nikola outlined plans for a range of hydrogen stations to support its coming fleet.

Excitement built, along with plans for two more hydrogen-powered heavy trucks. Partnerships with major industry players like Bosch and Iveco's parent company CNH Industrial lent credence to its claims, and an IPO saw its market value–albeit briefly–top that of Ford's. Six years from its founding and Nikola still had no product, but was promising a future line-up spanning the Nikola One, Two and Tre heavy trucks, along with the Badger pick-up, an electric dune buggy and a jet ski. While Milton had attracted a sizeable

Trevor Milton at the groundbreaking ceremony for Nikola's Arizona factory

following by this stage, his faith wasn't shared by everyone. "The only thing many people have against us is that we don't produce anything," he conceded.

That was about to change. The Nikola Tre recently entered production through its partnership with CNH Industrial in Europe. In the US, General Motors had signed a wide-ranging collaboration agreement to not only build its Badger pick-up but also supply battery and fuel cell technology for it and the heavy trucks. This raised red flags in many corners–wasn't Nikola supposed to have had all this technology ready in-house?

Nikola 2.0

Then came the Hindenburg Research report, accusing Milton of providing misleading statements on its technology status and manufacturing capabilities as he attempted to build up the company and attract partners and investors. Nikola denied all the charges, arguing the report was the work of "an activist short-seller" motivated by the desire to manipulate the market and profit from a decline in its stock price. Just days after the company issued a statement that it had "nothing to hide," Milton approached the Board of Directors and offered to step down as Executive Chairman. That role now goes to Stephen Girsky, former Vice Chairman of General Motors and a member of Nikola's Board.

The move is designed to salvage the company's reputation and diffuse the immediate pressure on it, but is it enough? "Trevor Milton is out and Steve Girsky is in as Nikola's new leader, but will this fix Nikola's damaged reputation? Not in the near term," warned Karl Brauer, a veteran industry commentator and Executive Analyst at iSeeCars.com. "There's now a perception of Nikola misleading investors and business partners, and this perception has overshadowed the value Nikola brings to the GM partnership, at least in the near term. The long-term benefits of alignment between GM and Nikola can still materialise, but until they do it's a black eye for both companies."

Others were more positive on the move. “In the midst of the doubt and accusations cast over Nikola, Milton’s decision to step down is commendable as he gives away his seat in an attempt to protect the company,” suggested Pedro Pacheco, Senior Research Director at Gartner’s CIO Research Group. Similar thoughts were expressed by Kevin Kelly, Industry Principal in Frost & Sullivan’s (F&S) Mobility division: “A fast change was required to save the valuation of the company and its relationship with the likes of GM.”

Nikola’s attention now turns to damage control and preserving key relationships. “Nikola needs to focus on saving its relationship with its partners in the automotive industry, most importantly its newly formed partnership with GM and the earlier alliance with CNH Industrial,” said Nishita Aggarwal, Research Analyst for Automotive at the Economist Intelligence Unit. This should be made easier by the appointment of Girsky. “As the mastermind behind Nikola’s alliance with GM, his thorough knowledge of the American automaker could be essential to make this partnership work,” Pacheco pointed out. “Girsky also has a considerable OEM experience, which could help the start-up mature at several levels and also may open the opportunity to further partnerships with OEMs.”

> “These guys create a culture and a dynamic, and within the market they create a buzz. They can drive a business valuation off of a LinkedIn post

Aggarwal pointed out that Girsky is known for his contribution in turning around GM’s fortunes, adding: “The fact that Girksy has been willing to take on the role suggests that he still sees potential in Nikola’s business and its technology. His position as Chairman will help to rebuild investors’ confidence, helping the company to restore its credibility and create a more transparent image.” Girsky has already indicated that he wants to have an independent review of how deep any questionable behaviour goes.

Lesson for others

One of the most unstabilising aspects of Nikola’s situation stems from having its Chairman so closely tied to the company’s image and success. F&S’s Kelly likens that association to what was seen with Steve Jobs and Apple, Elon Musk with Tesla and Jeff Bezos with Amazon. “These guys create a

The Nikola Badger will be engineered and built by GM

© Nikola

culture and a dynamic, and within the market they create a buzz," he told *Automotive World*. "They can drive a business valuation off of a LinkedIn post."

Nikola's stock price has roughly halved following the Hindenburg report, and recovery could prove an uphill battle. "It will struggle in terms of valuation until it has a product–a production version, not just a prototype," says Kelly. "That will be hard to do."

But it's not just Nikola that could prove a victim of Milton's strategy. Other start-ups could face tighter scrutiny moving forward, both around their technology and their leadership. "This situation will put a lot of doubt in the minds of many people in the industry, particularly in the financial sector, around start-ups," said Kelly. "Companies may start to re-evaluate just how much due diligence they have to do." For instance, they may want to see a product working, or hold an internal investigation into the ethics of the company. "This is especially valid if the company is tied to a figurehead," he added. By 'figurehead', Kelly refers to an individual that embodies the value of the organisation as opposed to the common US meaning of someone who holds the trappings of power but not actual power. "These figureheads are tied to the valuation of the company," he emphasised "They are what you are investing in. Trevor was seen as that, and now Nikola has lost it."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World EV Day: rivalry set aside for big picture focus

Ionity's Chief Executive Michael Hajesch speaks to Megan Lampinen about the significance of this inaugural event for the electric vehicle industry

Electric vehicles (EVs) will play a key role in achieving upcoming fuel efficiency and emission standards, but only if consumers are willing to make the switch. Uptake has been much slower than expected. 2017 marked the first year that electrified vehicle sales exceeded a million units, and new records have been set consistently since then. Data from the International Energy Agency (IEA) show that 1.98 million EVs were sold in 2018, jumping to 2.1 million in 2019. Going by 2019 data, the IEA estimates that EVs currently account for about 2.6% of global car sales and about 1% of global car stock. While that represents a 40% year-on-year increase, the numbers are undeniably small.

This year, players across the EV value stream kicked things up a gear with an official World EV Day on 9 September. According to the organisers, "World EV Day is a global movement, a day of celebration of e-mobility, and a day to shift the transition to sustainable transport with consumer, business and policy outcomes." A wide range of awareness-raising activities were held: Hyundai offered EV test drives, for instance, while Nissan celebrated production of the 500,000th Leaf EV.

© Ionity


© Ionity

> Many of our World EV Day partners could be considered as our market competitors, but if we look at the bigger picture, we are all working in unison to contribute to climate protection
>
> *Michael Hajesch*
> *Ionity*

However, due to restrictions around COVID-19, many of these activities were virtual and centred around social media. A big proportion of these focussed on charging.

Charging in the spotlight

The global fleet of 5 million EVs is currently supported by a network of just over 630,000 public charging outlets, and the bulk of these are in China. A shortage of charging stations is regarded as one of the biggest barriers for dealers when it comes to translating EV interest into EV sales. It is also flagged as a key consumer concern in countless studies. Little surprise then that charging infrastructure players are among the more vocal participants in EV Day celebrations.

"World EV Day is a landmark occasion for the entire global e-mobility sector to come together to mark the importance of the ongoing electrification of transport and travel," commented Michael Hajesch, Chief Executive of the joint venture Ionity. The company was set up by Ford, BMW, Daimler and Volkswagen Group in 2017 specifically to address charging across Europe's motorways. Ionity was one of the founding partners of this inaugural event. Other charging infrastructure partners include ABB, ubitricity and Volta, while the list of automaker partners includes BYD, Hyundai, Jaguar Land Rover, Nio, Nissan and Tata.

"The plans for World EV Day were in progress for some time, but the really exciting factor has been the snowball effect over the last few months," Hajesch told *Automotive World*. "We're now partnering with large and small scale organisations from across the green energy sector, such as international automakers and global and local charging infrastructure providers. Many of our World EV Day partners could be considered as our market competitors, but if we look at the bigger picture, we are all working in unison to contribute to climate protection, with a clear push to support the

shift to electric mobility from all angles. And that's really what it's all about–the bigger picture."

Many segment players have been vocal on the importance of the charging experience to overall EV success. Ideally, consumers are looking for a charging experience akin to the fuelling experience they have had with gasoline and diesel cars. Where those times are unavoidably longer, they are looking for locations that offer other amenities to pass the time. "The charging experience is a key factor in EV adoption rates," asserted Hajesch.

Which comes first: EVs or chargers

Opinions vary widely on the question of which comes first: charging infrastructure or EV models. For instance, Lucid Motors–the company behind the upcoming Air model that boasts a 517-mile range–suggests the models must come first. "Horses came first, then the stables," Lucid's Chief Executive Peter Rawlinson told *Automotive World*. "Gasoline cars came first, then the gas stations... Now, we expect the fast-charging infrastructure to follow the advent of the electric car. Otherwise it's putting the cart before the horse."

Hajesch takes the opposite view: "The deployment of charging infrastructures should precede the progress of battery driven vehicles to stimulate consumer confidence. If consumers do not have immediate and comfortable accessibility to reliable charging infrastructure, then they are unlikely to adopt an EV lifestyle." The problem, in his view, is that not all these attributes are fulfilled by the many charge point operator networks across Europe. What the industry has instead, he suggested, is a heterogeneous

ubitricity has been harnessing lamppost infrastructure to facilitate EV charging

landscape of charging infrastructure with major limitations.

"We at Ionity are pushing hard to deliver the ultimate customer experience," he added. That starts with availability, and the venture currently has 272 high power charging (HPC) stations, with more than 1,000 charging outlets along main European highways. An additional 51 locations are currently under construction. Ionity claims the technology that it has deployed is future-proof and can deliver up to 350kW per outlet, enough to serve today's vehicles as well as future ones. It also helps that the customer interface is the same in all countries, supported by a 24/7 customer hotline available in seven languages.

"Over the last few years, we have witnessed significant efforts from charging infrastructure deployment, but we still have a long way to stay ahead of vehicle deployment to provide confidence to customers when it comes to charging," he conceded.

Education

Charging alone won't secure an electric future, and a big part of the EV Day event centred around education. Numerous players in the segment have long been working on raising awareness, both around climate change and the role that EVs can play. Many markets have seen initiatives from governmental and regional authorities, international organisations, NGOs, automakers and charging infrastructure providers. However, most agree there is still work to be done. "We

Most EV models don't have the Air's 500+ mile range and may rely more heavily on public charging

© Lucid Motors

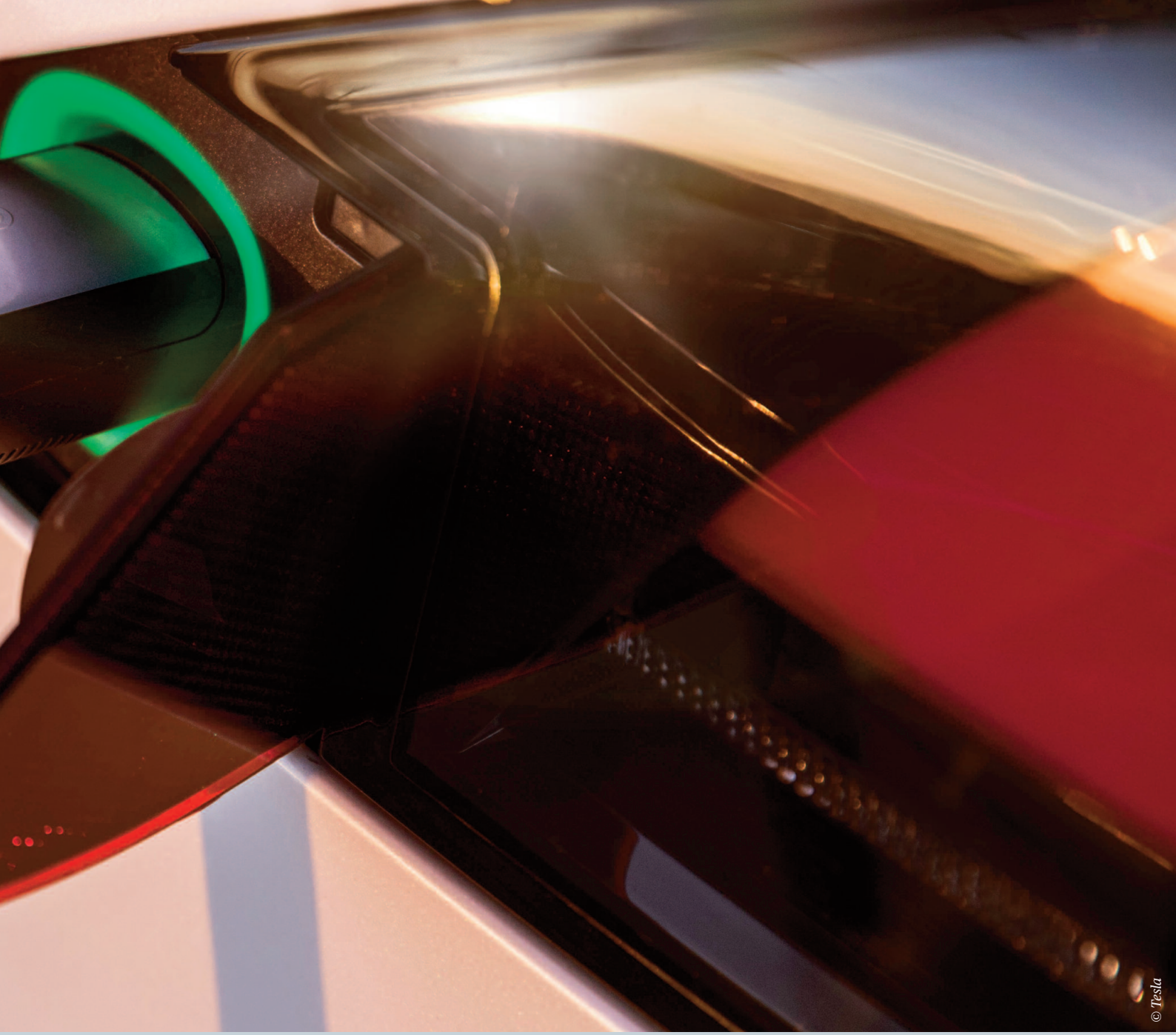
must all step up our game and take our share of responsibility," said Hajesch. "The automotive industry, which alongside the energy production sector, is the sector that has to improve the most. This means significantly reducing CO2 emissions from cars and other transport vehicles. In parallel, we need to ensure that consumers are aware of the progress that's being made in the auto sector."

Tremendous progress has been made in terms of battery technology, charging infrastructure, renewable energy production and the EV models on offer. The industry is in a very different position from where it was even just a few years ago, but not everyone has followed that progress. "Choosing an EV today is an entirely different story from what it was ten years ago," he pointed out. "It is no longer an early adopter market. Today, there are very few obstacles to having a battery driven EV as the single household car."

As of 2021, European consumers should have more than 200 different models to choose from, and some of these boast ranges of more than 400km. When it comes to charging, there are more locations set up and charging times have declined. Combined, these developments should do much to address range anxiety. "There's still a great deal to be done to increase awareness and educate stakeholders about the benefits of EV adoption, but we are clearly well on our way," Hajesch added. "I have no doubt that World EV Day will grow increasingly important over the coming years."

Tesla targets affordable EVs once more with new battery strategy

Buoyed by another profitable quarter, Tesla is looking less like a start-up and more like an established manufacturer, writes Freddie Holmes



Tesla has a history of staging flashy events to reveal new products, visions and milestones. Staged in a car park and introduced by a chorus of car horns, the company's 2020 Annual Shareholder Meeting and inaugural Battery Day was not one of these events.

Once the chorus of Teslas parked in front of the open-air stage quietened down, Tesla founder Elon Musk conceded that "it's a little hard to read the room with everyone in cars, but it's the only way we could do it."

Emphasis quickly turned to developments in China, where the electric vehicle (EV) maker hit full volume production at its Shanghai Gigafactory in March. The facility will produce the Model Y and assemble the Model 3. "We wouldn't have had the results that we did this year without the efforts of the Tesla China team," he said. The facility should produce more than a million vehicles a year at some point in future, he advised, although little attribution was given to that statement other than: "Yeah, it's cool." Another landmark in 2020 was volume

Tesla has now achieved four consecutive quarters of GAAP profitability

production of the Model Y–"the smoothest launch we've ever had"–and a reduction in the cost of Tesla's solar panel roofs.

But perhaps most importantly for the car park of shareholders was the news that Tesla has achieved four consecutive quarters of profitability based on generally accepted accounting principles (GAAP). It is an important distinction from non-GAAP or 'adjusted earnings', which tend to cast more of a favourable light on a company's financial performance. In 2016, the company received letters from the SEC to avoid non-GAAP metrics in earnings releases. In short, GAAP profitability is a true sign that a company is making money.

Karl Brauer, a seasoned industry commentator and Executive Analyst at iSeeCars.com, was impressed with the news. "With GAAP profitability achieved and additional plants coming online it seems safe to assume Tesla is over the proverbial hump in terms of transitioning from a start-up to a sustainable business model," he commented shortly after the event. "It took a while–approximately 15 years–but by god I think Elon's done it."

Turning to future developments, Musk announced a new initiative to halve the cost of its battery packs by 2025. Improvements will cover everything from cell design and manufacturing to the materials used for anodes and cathodes and the integration of cells within the vehicle. This next generation of cells will be larger and take a different shape, allowing for five times greater energy density, a 16% increase in range and six times more power than previous cells.

Producing affordable EVs has long been Tesla's goal, and the Model 3 has certainly made inroads in the mass market even alongside conventional diesel and gasoline cars. However, it is difficult to justify a US$40,000 vehicle as being affordable for the average consumer, and the Model S, X and Y remain firmly in the premium

Tesla's proposed US$25,000 EV will rely heavily on its new battery technology

segment. By 2023, Musk suggested that the company could launch a new, as yet un-named US$25,000 car. Equity research firm Jefferies noted that an "18-36 months time frame to accrue savings looks logical," and that the company had provided "better insight overall" into how production costs will be reduced.

The new cells are already being produced at a 'pilot' production line near its Fremont factory in California. By 2021, this line should achieve annual cell production of around ten gigawatt-hours. "The cost per kilowatt-hour curve, and the affordability of electric cars in general, is not improving fast enough," said Musk.

"It seems like it is a race to the US$25,000 EV with a super-powered battery," commented Alyssa Altman, Transportation Analyst at digital transformation consultancy Publicis Sapient. Altman highlighted General Motors' recent announcement that it too has a new battery strategy under the Ultium brand. "Tesla has proven that it can deliver and deliver quickly, but will a powerhouse like GM beat them to it?" she asked. "We need to watch closely who has the true ability to own the full ecosystem–that will define the winner. It won't necessarily be the first one to create the $25K car with the more powerful battery."

While the proposed advances in battery technology are significant, it is Tesla's move toward sustained profitability that has impressed industry observers most. "[This was] probably the best Elon Musk we've seen in terms of concrete evidence of the company's performance, including sales and profitability in a tough year," commented iSeeCars' Brauer.

Tesla's Battery Day comes off the back of a devastating period for competitor Nikola Motor, with allegations of fraud shortly followed by the resignation of its founder and Executive Chairman, Trevor Milton. The company's recently announced partnership with General Motors is under pressure almost before it has begun. Stephen Girsky, a former Vice Chairman at General Motors, will take over the position as the company seeks its own path to profitability. First priorities will be commencing production of its first vehicles, and ensuring shareholders keep faith in its long-term vision.

Ford's Chief Technology Officer offers his take on future-proofing

Ken Washington offers an update on the latest developments around autonomous driving, connectivity and last-mile delivery.
By Megan Lampinen

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Future-proofing takes a slightly different form at every automaker, though most agree on the foundations of connectivity, autonomous driving, shared mobility and electric propulsion. At Ford, this approach is shaped by a clear corporate policy of balancing immediate business priorities with near-term opportunities and long-term potential. “At Ford, we are committed to working in the now, the near and the far, in parallel,” asserted Ford’s Chief Technology Officer Ken Washington, speaking at the Evercore ISI New Mobility & AI Forum. Washington used the platform to provide an update on the company’s innovation strategy, which despite the novel coronavirus pandemic and economic downturn continues to power ahead.

Autonomous journey

Ford has been actively preparing for an autonomous future from several angles, including the formation of the Ford Autonomous Vehicles LLC business unit, its stake in self-driving start-up Argo AI and its partnership with Volkswagen Group. While the aim is to have a self-driving robotaxi scheme in place by 2022–one year later than initially envisioned due to the coronavirus–considerable focus is currently given to the gap between its Level 2 (L2) drivers assist systems and L3.

“One thing we’ve learned on our AV journey is that L2 and L4 are bleeding more closely together than originally expected,” said Washington. “When we first started this, we thought of them as totally separate activities, but

The Mustang Mach-E’s Co-Pilot360 Technology includes Active Drive Assist, allowing for hands-free driving

> We believe that robotic delivery will be a reality in the future, though it is still in its infancy today
>
> *Ken Washington*
> *Ford*

that's changing as sensors grow more capable and artificial intelligence (AI) becomes more real." The big challenge with the step to L3 centres on regaining the attention of the driver when the system needs to hand back control. While L3 automation can handle the driving tasks in some situations, it has its limits and the driver needs to remain alert. Solving that issue would be "a key milestone" in Washington's book.

"We aim to crack the barrier between L2++ and L3 for highway driving in the future," he added. Terms like L2+ and L2++ so far lack any official definition, but rather refer to a continuum of capabilities between L2 and L3. "As we move towards a solution that allows you to be truly hands-, eyes- and mind-off, we are looking at interior sensing capabilities that can regain the driver's attention. We haven't come forward with an announcement date but it's in our roadmap." At the moment, teams in Palo Alto, Dearborn, Aachen and Israel are working together to solve this problem.

New software stack

Development work has been underway for some time on a new software stack which will open the gate to greater functionality. The biggest change will be the centralised compute platform. Specifically, engineers are working on a decomposition of the sensor set so the intelligence moves from sensors and actuators at the edge to a centralised compute cluster. A large memory module will allow sensors to share memory with each other. "We can then provide over-the-air (OTA) updates that affect the performance of sensors and actuators," said Washington. The next iteration of the stack also moves towards a zonal power architecture. This would allow power to be directed only to certain zones, as and when required.

This updated tech stack will debut in an all new electric commercial vehicle in 2025 or 2026. What will not appear in this vehicle will be LiDAR, one of the key technologies in many self-driving systems (SDS). The problem, says Washington, is the cost: "It is important that our tech stack for retail and commercial vehicles remains affordable. At this point, LiDAR is still not at a cost point to make it so." While LiDAR will feature in the upcoming robotaxi

fleet, where the business model makes it more viable, Ford plans to provide L2 and L3 capability using a mix of long- and short-range radar and high-definition (HD) cameras. It will also call on sensor fusion and the centralised compute module mentioned above. “Once you have the ability to move the imaging from the radars and the cameras into a central compute module, you can do pretty sophisticated sensor fusion and AI to achieve the perception required for L2 and L3.”

While this new software stack will debut in an electric vehicle (EV), it could also apply to an internal combustion engine (ICE) model. Washington pointed out that there are many areas of overlap when it comes to electric architecture within EV and ICE models, and that Ford is keen to leverage developments in one field for the other. “The IVI stack is not any different in an EV than it is in an ICE. You can merge and share memory from multiple sensors in the same way. The zonal power strategy we will take has only a minor difference, having to do with power distributed to propulsion and sustainability

Ford plans to begin deploying C-V2X technology in its vehicles

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Ford has been working with Agility Robotics on a humanoid robot called Digit

modules," he noted. "In general, a lot of sharing can happen across ICE and EV platforms and we will leverage that to create advantages of scale."

Smart cities, smart ecosystem

Ford isn't just about making smart vehicles; it is positioning for a wider play within the emerging smart mobility ecosystem. The company has been paying particular attention to smart city technologies like 5G and cellular vehicle-to-everything (C-V2X) communications. "These will allow us do L3 driving with more confidence," noted Washington.

Ford has been a vocal champion of C-V2X, which it regards as a step on the evolutionary path to 5G. The company was one of the first to commit to a launch date for C-V2X communication technology in its vehicles, set for a China debut in 2021. Ford is also one of the partners behind Michigan's project to establish a dedicated corridor for connected and autonomous vehicles. The purpose-built route will connect Detroit and Ann Arbor, with infrastructure solutions allowing for a mix of connected and autonomous vehicles, traditional transit vehicles, shared mobility, commercial trucks and personal vehicles. "This is to be a showcase for developing smart vehicles in a smart world," he noted.

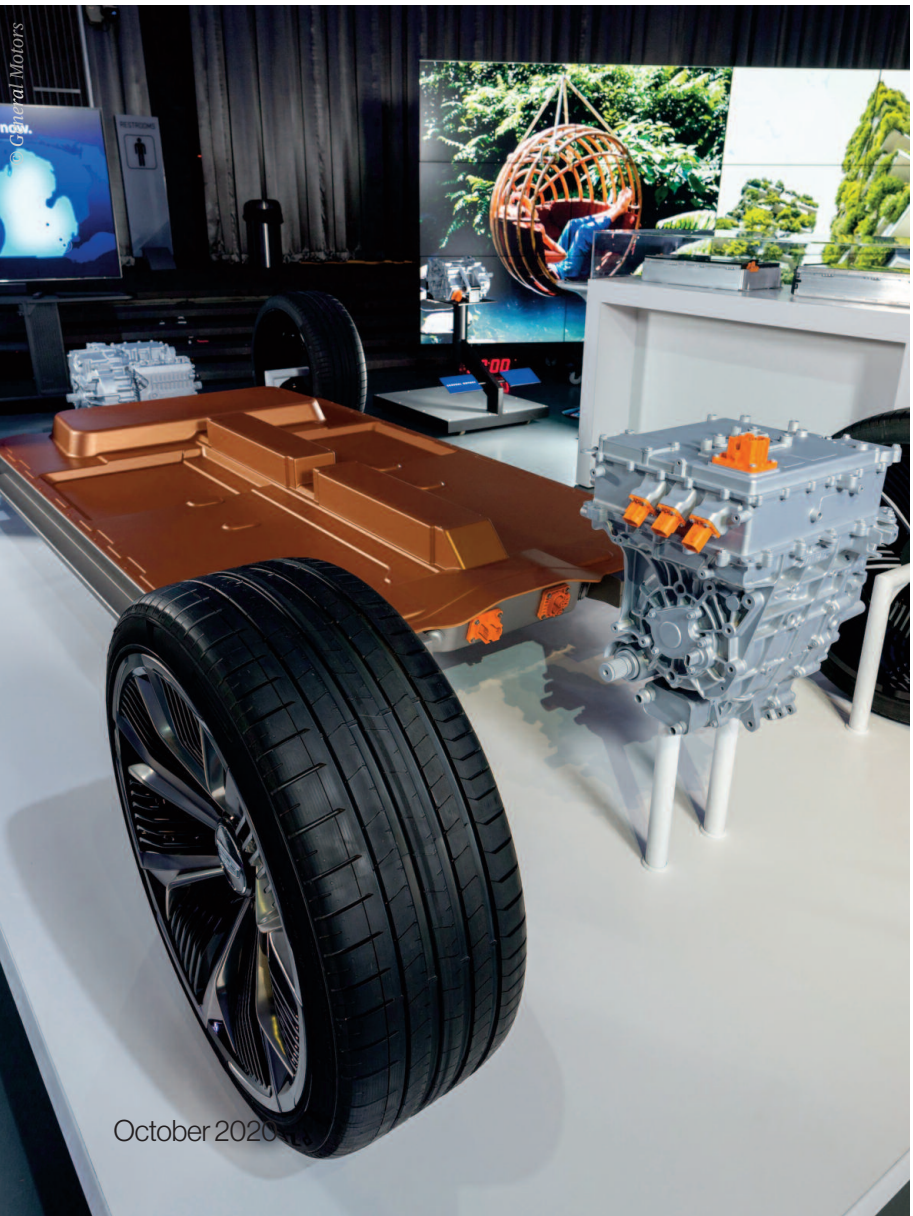
In this smart world, last-mile delivery will play a key role and Ford is actively exploring automation here as well. It has been working with Agility Robotics on a humanoid robot called Digit, which can convey packages from a vehicle to an individual's front door. "We believe that robotic delivery will be a reality in the future, though it is still in its infancy today," said Washington. "Projects like Digit, which are not in production yet but simply demos, offer a glimpse of the future that is coming."

Ford is also working with other robotics companies as well as universities and strategic partners on various aspects of automated last-mile delivery. This autumn it plans to open the new Ford Motor Company Robotics Building, a research facility at the University of Michigan. Designed as a national centrepiece in robotics research, learning, and collaboration, the location offers space for teaching, experimentation, and testing. "We will use this facility and our partnerships around it to help us accelerate development of next generation technologies like advanced robotics and drones," Washington added. "All this is coming, and we are in the middle of that mix."

How far will GM and Honda take their alliance?

These two automakers are upping their relationship to a new level, writes Megan Lampinen

The combined challenges of a global pandemic, its subsequent economic downturn and CASE (connected, autonomous, shared and electric) mobility are putting a serious strain on automaker finances. Margins for many players have been too narrow for comfort, and the pinch is only getting stronger. Even before COVID-19 appeared on the scene, former FCA Chief Executive Sergio Marchionne was urging the merits of scale-boosting alliances with his 'Confessions of a capital junkie' pitch to investors. Marchionne argued that the industry has never been able to earn its cost of capital over a cycle and that consolidation was the only answer.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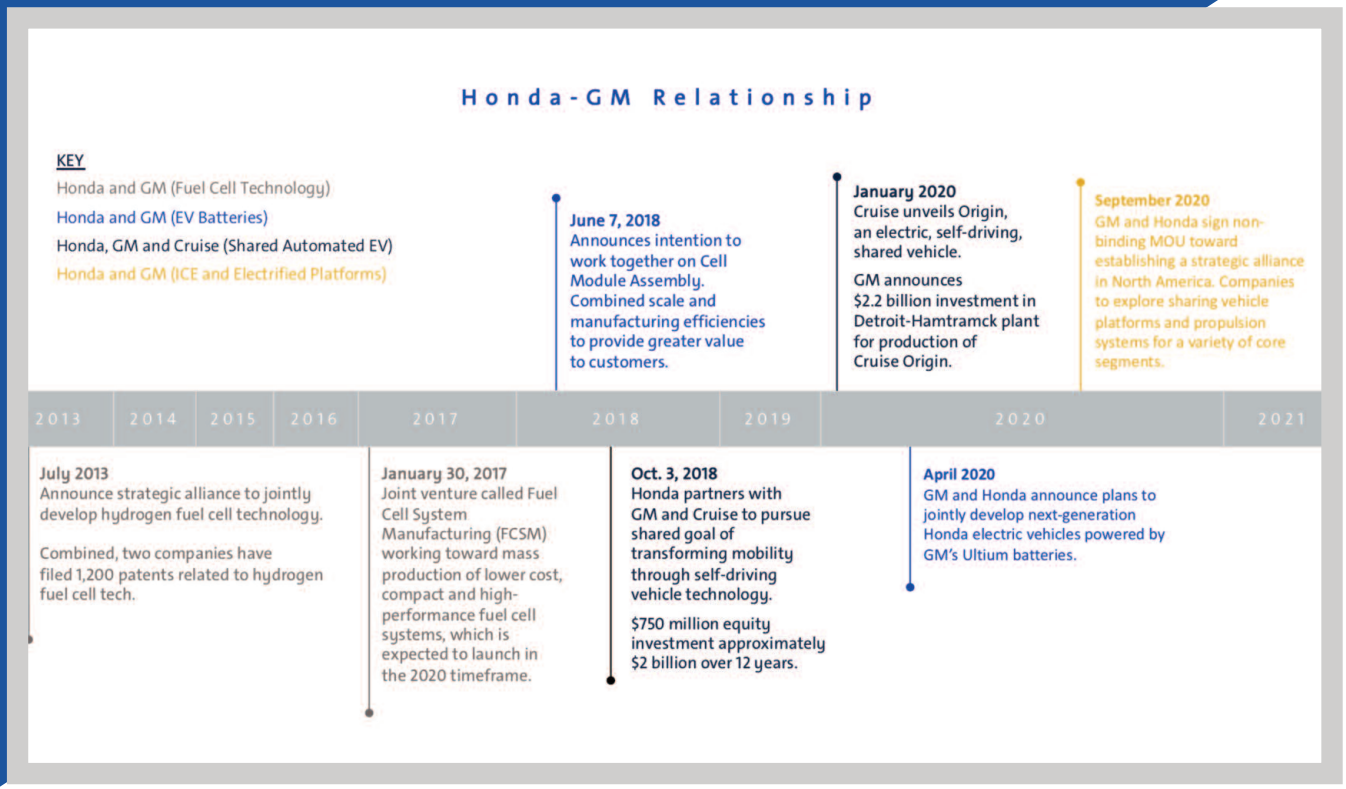
But consolidation doesn't always mean an outright merger. True, Geely took ownership of Volvo, and PSA and FCA plan to merge, but plenty of others are simply pooling resources on specific areas of development. Ford and Volkswagen, for instance, are collaborating on electric vehicles, commercial vehicles and autonomous driving. Moving forward, all forms of collaboration will only become more important in this increasingly demanding ecosystem.

Spotlight on GM and Honda

The most recent development on this front shines a spotlight on General Motors and Honda. These two companies have been in the business of making cars for generations and both are determined to remain key players in the shift towards new, clean mobility. They have worked together on various technologies over the past two decades, including, more recently, collaboration around fuel cell technology, batteries and the Cruise Origin shared autonomous vehicle. Now they are taking the partnership a step further as they explore sharing vehicle platforms and propulsion systems for the North American market.

"This is very significant news," commented Michelle Krebs, Executive Analyst at Cox Automotive. "GM and Honda have been working on a number of projects over the years... This takes their relationship to a whole new level." Under a non-binding memorandum of understanding, the partners intend to launch jointly developed vehicles under their own brands. They are moving quickly, and engineering work could begin as early as next



year. They also intend to work together on purchasing, R&D and connected services. The idea is that saving money on these areas will leave them more funding to put towards advanced CASE technologies, which are rapidly devouring financial resources.

"What's notable about Honda is that it has remained fervently independent while others merge or pursue joint ventures," Krebs added. Honda's independence has been the subject of speculation for some time, given its relatively small scale compared to many of its rivals. Earlier this year the Japanese government had reportedly tried to encourage a merger between Honda and Nissan, but neither side showed much interest. "Honda is not as small as it seems, as it actually sells more cars than FCA, one of the main players in US," said Pedro Pacheco, Senior Research Director at Gartner.

Given the history between GM and Honda, news of this expanded partnership isn't terribly surprising but it does speak to the wider trends playing out across the industry, which have been accelerated by COVID-19. "The two companies had an existing relationship and the deepening of these types of relationships are an expected trend in the automotive industry," said Jessica Caldwell, Edmunds' Executive Director of Insights. "As we face an expensive future filled with electrification and autonomous technology, we expect to see more alliances, partnerships and joint ventures due to escalating development costs and new, untraditional competitors."

Pacheco shared a similar view. "Last November we saw the FCA and PSA merger announcement, and now we have a relatively similar event, where automakers are joining forces in order

The partners' product line-ups are seen as complementary

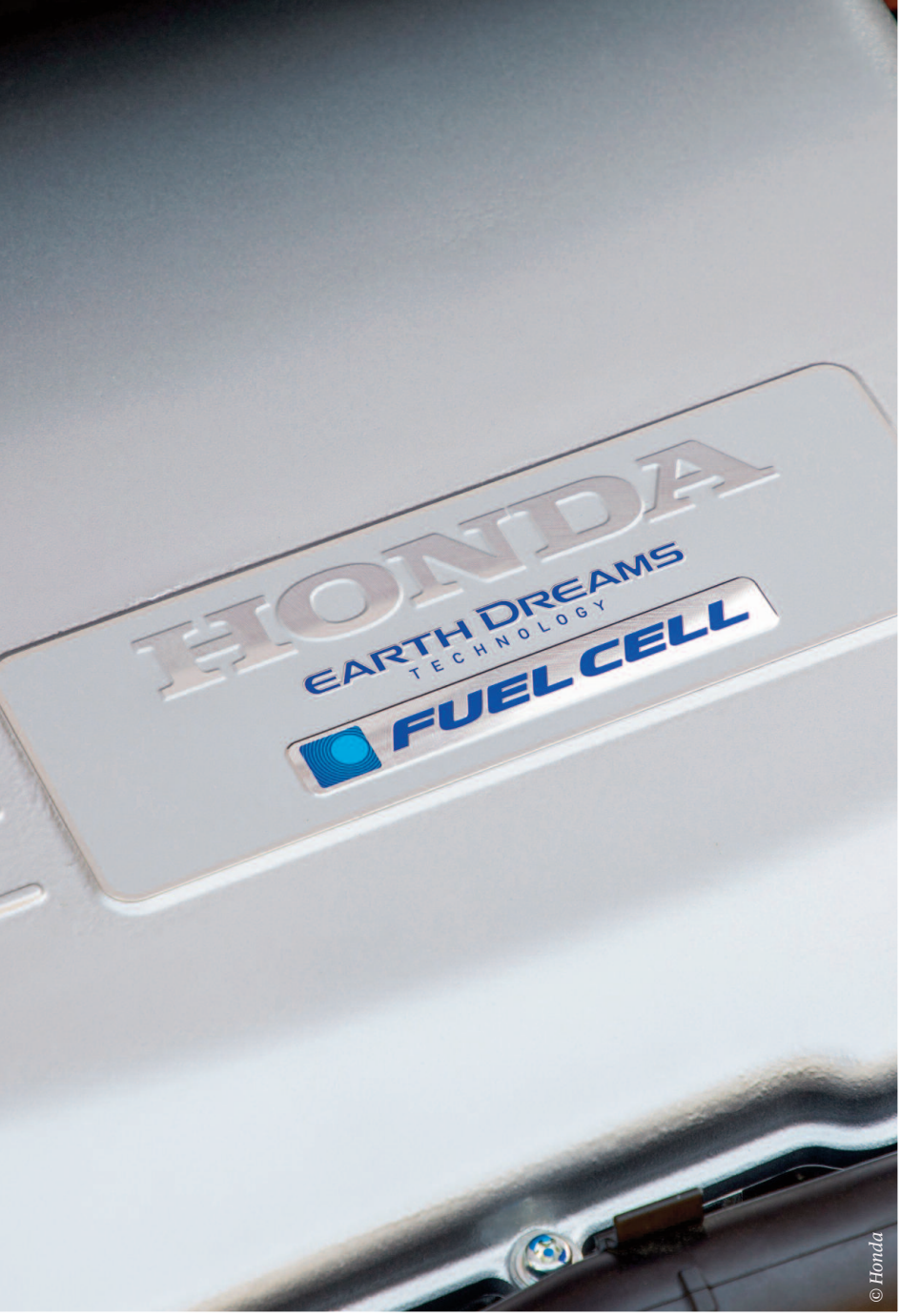
to cope with the challenges of mobility transformation, especially in terms of economies of scale," he observed. He sees COVID-19 as more of "an accelerator" behind this trend than anything else.

A good fit

There were plenty of potential partners for both GM and Honda to choose in this North American partnership. Just how good a fit are these two for each other? "Their current geographic footprints in North America and product strengths complement each other well," said Brian Moody, Executive Editor at Autotrader. "From fuel cells to full-size trucks to automated service vehicles, the potential is enormous."

"From a product standpoint, a GM and Honda relationship makes sense as their core competencies are largely complementary rather than competitive," Caldwell told *Automotive World*. Pacheco pointed out that "as GM is leaving the sedan market, Honda is still strong in this area. On the other hand, GM has a stronger presence in the pick-up and SUV market." But there is a downside, he warns: "Many consumers are attached to the brand values of Honda or GM brands and will know when a certain model is not developed by the company."

> "What's notable about Honda is that it has remained fervently independent while others merge or pursue joint ventures



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Honda and GM have been collaborating on fuel cell technology

A transformative decade

The industry's reception of the news has generally been positive. "An established automaker with a century of building, marketing, selling and servicing vehicles has the best chance at cracking the code of personal transportation and Mobility 2.0. Combining the power of two successful, established automakers– even better," commented Moody. He went on to suggest that this particular combo "could be very powerful" as each sides brings "a unique set of products, services, and fans."

This latest collaborative project is significant, but it may not lead to a more intimate relationship. "I don't believe the alliance will go much further, especially because it is limited to the US market, rather than being global," Pacheco suggested. "That shows there is a limit."

For Storey, one of the key takeaways from all of this is the change in management strategy. "What stands out for me is how agile GM has become under Mary Barra and how prepared it is to embrace courses of action which it would have avoided in

Jonathan Storey of Automotive Reports is less concerned about potential downsides. "I don't see a problem in the market," he stated. "I'm sure any jointly developed models will be sufficiently distinguished to work for the different brands." It is not yet clear if joint manufacturing is on the books, but even if it is, Storey expects a smooth path forward: "In the past I think Honda would have been reluctant to see one of its products built in a GM plant, but that shouldn't be a major concern now."

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> What stands out for me is how agile GM has become under Mary Barra and how prepared it is to embrace courses of action which it would have avoided in the past

the past. I don't think these two companies could have worked together effectively in the past."

As so many industry watchers and observers point out, the current pace of change is unprecedented for this industry, and the rules of the past no longer apply. "The automotive industry is headed into what will be a transformative decade, so clearly everything is on the table right now," said Krebs. "We have been seeing and likely will continue to see more of these joint ventures and strategic alliances as we move toward a future that requires significantly improved efficiencies, huge investments in future technologies, and a variety of mobility solutions. The costs of this transformation will be enormous. Every automaker is asking the same question: Do we share the costs or go it alone?"

Competition heating up in the zero-emissions delivery space

Volta Trucks is the latest name hoping for success in the zero-emissions commercial vehicle segment. By Xavier Boucherat

A number of cities remain on target to restrict internal combustion engines (ICEs), if not ban them from the road altogether. Paris is among the front-runners, with plans to outlaw diesel vehicles by 2024, and all ICEs including gasoline by 2030. At a time when demand for urban delivery is rising, particularly in the wake of the novel coronavirus disease (COVID-19), the implications for delivery fleets and commercial vehicle operators are serious, and several truck makers are already gunning to meet new requirements.

Thus, competition is gathering pace. Daimler and Volvo are both nearing the launch of a pure electric truck. The former has also developed the eSprinter van, and last month found a customer in Amazon, which purchased 1,800 units. Meanwhile, a host of new names will compete with them, such as Rivian, Workhorse and Chanje. Rivian has also sold to Amazon, with an order of 100,000 units reported, whilst Workhorse–which recently entered into a deal with Hitachi America to build a national dealer network–has sold 1,000 units to UPS. Chanje has sold 1,000 of its vans to FedEx.

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The latest name to announce plans is Volta, a Sweden-based start-up which this month unveiled its Volta Zero truck. When loaded, the fully electric 16-tonne truck has a range of 125 miles, which Chief Executive Rob Fowler called more than enough for the needs of most urban fleets to perform return-to-base operations. The company said it has already taken pre-orders. In an interview following the launch, Fowler declined to give details on customers, but said the total amount lay between 100 and 500.

Asked about production and sales goals, Fowler said the company would follow the market: "Ultimately, we will work in response to customers. We see London and Paris as our first marketplaces, largely due to regulations. We see an expansion across mainland Europe as our volumes start to increase, but there are no set targets for regional distribution." By the end of 2022, the company hopes to have put 500 vehicles on the road, rising to 5,000 vehicles a year by 2025 and increasing further beyond that.

People-centric trucking

The Volta Zero is striking in appearance: the removal of the ICE, said Carsten Astheimer, Lead Designer of the vehicle, made it possible to put the safety of both the driver and other road-users at the heart of the vehicle. Importantly, the substitution of the engine with batteries, which are placed underneath the rear chassis, means the driver's seat no longer sits high up, but close to the ground in a central position. Bringing the driver to eye-line level with other road users allows for easier communication, potentially reducing accidents, whilst a 220-degree field of vision allows drivers to operate within the busy urban environment. A suite of advanced driver assistance systems (ADAS) will further improve safety.

More broadly, said Carl-Magnus Norden, Co-Founder at Volta Trucks, the company's goal is to create a vehicle that makes cities both safer and more pleasant, whilst providing fleets the best efficiency, and drivers the best experience. "We want to be friendly, transparent and

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Volta Chief Executive Rob Fowler said the number of collisions involving trucks in cities remains unacceptable. The Zero has been built with other road-users' safety in mind

progressive," he said. "Our trucks should fit perfectly into the human-centric cities of tomorrow. These cities are made for people, not for cars or trucks."

"The vehicle needs to serve the urban community," agreed Astheimer. "The design is where technology meets nature. It's futuristic, but sustainable." Battery-powered mobility, he added, has enabled the company to optimise safety by maximising visibility and minimising the cognitive overload for the driver. A natural palette of colours, he added, creates a design that will complement the urban environment.

Not bothered by Brexit

Interestingly, Volta has chosen the UK as a manufacturing base. This comes ahead of the country's departure in earnest from the European Union, with the one-year transition period set to end on midnight 31 December 2020. The pair are yet to reach a deal on trade, with efforts hampered by COVID-19, and doubts over reaching an agreement before the deadline have been expressed on both sides. Should a deal not be reached, the UK's relationship with the EU will revert to World Trade Organization (WTO) rules, a significant feature of which is tariffs.

But Fowler maintained that the UK was the right choice for the company, particularly given the technical challenges in building a brand new vehicle. "We wanted to access great quality engineering talent," he said, "and that's exactly what we've been able to do in the UK... The expertise is very good. We want to develop an absolutely outstanding product, and building in the UK gives us the best chance to do that." Where possible, he added, the company will look to build a local supply chain. It aims to reach full production by 2022, although trials will begin before that, as the company works to assess use-cases and applications by customers.

Federal policy and pandemic shape US electric vehicle outlook

The novel coronavirus has had a big impact on the EV segment, but the outlook also hinges on the results of November's presidential elections. By Ian C Graig

The coronavirus is having a major impact on virtually every aspect of the US economy, and the market for electric vehicles (EVs) is no exception. EV sales, like overall vehicle sales, fell sharply in the spring of 2020 as the economy contracted and consumers and companies cut back on spending. While the broader economy and the automotive market have rebounded some during the summer and autumn, passenger vehicle sales, including sales of EVs, will be down for the year. Looking beyond 2020, most analysts believe the long-term US outlook for EVs remains bright due to advances in EV batteries, the availability of a growing number of EV models, and increased investments in EV charging infrastructure. The pace of growth in the US EV market will also be affected by federal government policy, which will depend in part on the outcome of the November presidential and Congressional elections.

A sudden downturn

North American passenger vehicle sales were down almost 35% year-on-year through the first half of 2020–and the decline in sales of EVs was even larger. EV sales to personal customers slumped as buyers were hesitant to buy models whose price tags are generally higher than their non-electric competitors. Automotive fleets that were starting to boost EV investments before the coronavirus delayed new EV orders as revenues fell due to the pandemic. The situation in the US is thus very different from that in Europe, where sales of battery-powered vehicles rose during the first half of 2020, driven by tough European emissions targets and EV mandates.

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The pace of growth in the US EV market will also be affected by federal government policy, which will depend in part on the outcome of the November presidential and Congressional elections

The decline in EV sales in the US is partly attributable to trends in California, the key US market for the segment. On 19 March, California became the first state in the nation to

Charging station operators reported sharp declines in the amount of time customers were using their stations during the spring

issue a statewide stay-at-home order in response to the coronavirus, and 34% of California dealerships reported as of early April that sales had declined 80%-100%. EV sales in California had been strong in the first quarter but dropped by about 45% year-on-year during the second, according to estimates by the California Energy Commission.

Another challenge facing EVs in the US is low gasoline prices: the Energy Information Administration (EIA) reports that, while the national average price of regular gasoline was US$2.60 per gallon at the start of 2020, it had fallen to US$1.81 in late April and today is US$2.18. The same pattern is seen in California, where a gallon of regular gasoline cost over US$4.00 at the start of the year, fell to US$2.65 in late April, and today is US$3.10. The EIA projects the national average price of gasoline will decline to US$2.03 per gallon in December and average US$2.28 in 2021-well below pre-pandemic prices.

Low gasoline gas prices are lessening one of the big appeals of an EV: a lower cost of ownership due to lower fuel costs. The impact may be largest on plug-in hybrids, where fuel-cost savings are a major driver of demand, and less on battery-electric EVs, where the purchase decision is driven as much by other factors (advanced technology features, environmental concerns, etc.). But low gasoline prices will slow a shift toward EVs in the US.

EV boosters point to the one potential benefit of reduced vehicle emissions due to the coronavirus: a dramatic improvement in air quality and increase in clear skies in cities like Los Angeles and New York, which can serve as a reminder of the environmental and health benefits of reducing vehicle emissions. This side effect of the pandemic is fuelling interest in cleaner transportation alternatives, though use of mass transit (an important market for EVs) has fallen sharply this year.

The market for EV charging infrastructure has been less affected by the coronavirus and the economic downturn. Charging station operators reported sharp declines in the amount of time customers were using their stations during the spring, but there has been a rebound in activity as driving increased. On a side note, most EV chargers in the US are located in parking lots of restaurants, hotels, offices, etc.

The coronavirus seemingly has not eroded the commitment of key states to further development of charging infrastructure, which remains relatively undeveloped in the US. Construction of new charging stations that was temporarily on hold early in the pandemic has resumed. Charging infrastructure projects are also largely funded through longer-term contracts by governments, automakers, power utilities, and electrical equipment companies-though state budgetary pressures due to the coronavirus could cause funding issues in the future.

How fast a rebound?

While forecasters see a rebound in the global EV market in late 2020 and 2021, the rebound will clearly be strongest in Europe and China. The rebound in the US market will likely be less pronounced, though US EV sales could get a boost from the introduction of new models by Tesla, Ford, and General Motors, potentially including several electric versions of popular pick-ups. Delays in EV purchases in the US could build demand for EVs in future years, particularly since it gives automakers more time to introduce new models.

Even with these new models, the US will lag other EV markets over the near term due to consumer preferences and lower fuel prices but also due to government policy. The Trump administration has eased fuel economy and greenhouse gas (GHG) emissions standards for light vehicles and is trying to overturn California's zero-emission vehicle (ZEV) mandate, which helps drive EV sales in California and the dozen other states that follow its vehicle emissions rules. As a result of the administration's actions, which face fierce court challenges from states and environmental groups, automakers in the US are under less pressure to boost EV sales and meet stringent emissions standards than in other markets.

EV advocates have called on Congress to take steps to boost federal incentives to stimulate EV demand. Most notably, they have called on lawmakers to expand the US$7,500 federal tax credit by raising a cap that currently prevents buyers from the two largest US producers, Tesla and General Motors, from qualifying for the credit. The Trump administration and many Congressional Republicans have opposed any such changes and managed to block past efforts to expand the availability of the EV tax credit, but Democrats vow to keep trying.

California also gives rebates to consumers for buying EVs, and the state is considering alternative incentives like 'fee-bates' to drive ZEV sales. Any new ZEV programme enacted by California, or an extension of the current programme, would require a new waiver from the Environmental Protection Agency, which California likely would not receive from the Trump administration-but could receive if a Democrat is elected president in November. California this week announced that it would adopt policies to ensure that all in-state sales of new passenger vehicles would be zero-emission by 2035.

EV advocates also want Congress to expand funding for EV charging infrastructure through either coronavirus-relief or infrastructure legislation. The Senate and House have both considered proposals for funding a nationwide EV charging network, as well as proposals for a

new EV charging infrastructure loan programme, policies to encourage electrification of corporate fleets, and extension of a credit for installing EV chargers that is due to expire at the end of this year. California, Oregon, and Washington are also collaborating on building EV-charging corridors, a regional policy being considered by states on the East Coast as well.

The outlook for future actions on these and other issues with a direct impact on the EV market will clearly be affected by the outcome of this year's presidential and Congressional elections. The Democratic presidential nominee, Joe Biden, has proposed a major increase in federal support for vehicle electrification, including investments in charging infrastructure, electrification of the nation's fleets of transit and school buses, customer purchase incentives, and greater federal investment in R&D related to 'clean' automotive technologies. Biden has also vowed to propose new stringent GHG emissions standards for vehicles. While President Trump has not offered a detailed policy agenda for his second term, the policies proposed by Biden differ significantly from those implemented by President Trump during his first term.

> "The Trump administration has eased fuel economy and greenhouse gas (GHG) emissions standards for light vehicles and is trying to overturn California's zero-emission vehicle (ZEV) mandate

Like markets around the world, the EV market in the US seems destined to grow in the coming years even though the speed of growth has been slowed by the coronavirus. Looking ahead, growth in the EV market in the US will be driven by fuel prices, improvements in batteries and other key EV technologies, the availability of more and lower priced EV models, and the rate of recovery from the current economic downturn. But federal government policy will also have impact on the pace of growth in the US EV market, at least until EVs no longer need government incentives to achieve price parity with non-electric vehicles. The near-term outlook for the EV market in the US will be thus also be affected by the outcome of this November's elections, which could help determine whether the federal government expands the types of incentives that are helping to boost EV demand in Europe and elsewhere.

About the author: Ian C. Graig, Chief Executive of the Washington-based policy research consultancy Global Policy Group, has written for Automotive World on a wide variety of US public policy trends and their implications for the automotive industry


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Will cyber crime kill the automated vehicle?

Hope for the best, plan for the worst, says Guidehouse Insights' Sam Abuelsamid: the cyber threat to AVs is real, but the industry can take steps today to ensure resilience

There was a time when the only real security concern for vehicle owners was that someone would pop their lock and either steal the stereo, or hotwire the engine and drive off. However, as we add increasing connectivity and the electronic controls that will eventually lead to full automation, the risks become exponentially greater. Cyber security is a very real concern that all automakers and suppliers deal with daily.

There was never much cause for concern around cyber security until the late 1990s; even then, it was closer to 2010 before most people really started paying attention. In the early days, most electronic control units (ECUs) in vehicles weren't even reprogrammable. The algorithms that ran on those relatively primitive microcontrollers, which powered systems like antilock brakes, were actually encoded right on the silicon dies.

In some cases, a chip could be replaced with modified calibrations for the engine management or transmission. Even when reprogrammable flash memory became available, someone would need physical access to the vehicle and a proprietary diagnostic tool to make changes. At that point, you were more likely to break–or 'brick'–the ECU than accomplish a malicious hack.

Fast forward to 2020, and the majority of new vehicles have an embedded LTE data modem, Wi-Fi and Bluetooth, and many reprogrammable safety critical ECUs. Within the next few years, nearly all new vehicles will be connected in some way with 5G and vehicle-to-everything (V2X) joining the communication suite. At the same time, more sophisticated, partially automated systems are becoming commonplace.

As we deploy highly automated vehicles (AVs) that can operate without any human intervention, connectivity becomes essential. After all, how can you tell a car to go park itself, or return from the parking garage, or summon a robotaxi if you can't communicate with it? AVs will also need to download map updates, traffic and road conditions, enable teleassist capability, and more in real time.

Why hack a car?

Who is likely to attempt a hack on a car, and why? There are those who will attack a system just to see if they can do it, and what they can accomplish. Similarly, the vandal may simply be out to cause some seemingly minor trouble, like disabling a friend's car. The more troubling cases could involve active attempts to steal data or otherwise commit financial crimes, and those involving state actors.

The first confirmed hacks shared with the public came out in 2015, and both were executed by security researchers. A team from the University of Washington managed to get into GM's OnStar telematics system and show how they could manipulate steering, braking, the engine, and other systems remotely. GM was notified of the vulnerability and corrected it before it was made public. A similar attack was famously executed by Charlie Miller and Chris Valasek on a Jeep Cherokee using vulnerabilities in the Chrysler Uconnect system and wireless provider Sprint. That incident led to the recall of more than one million vehicles to have their telematics systems updated.

> "The new verification tools used to continuously test flaws in the software could be exploited to inject malicious instructions. Access to code repositories must be controlled and changes must be documented, maintaining a chain of trust

Imagine a scenario in the not too distant future where thousands of AVs roam around a large city, and millions exist worldwide. Each is continuously connected to the others, as well as data centres. What if those vehicles suddenly came to a stop, and a message appeared on infotainment screens demanding payment of one million bitcoins to release the cars? There would be instant gridlock across countless cities.

This is an example of a ransomware attack, which in truth is probably the least of the industry's worries. What if someone found a way to infiltrate a data centre and send a command to the entire fleet to accelerate as quickly as possible? Or to tell every AV to turn left immediately? The potential casualties in cities around the world could be enormous. This is an unacceptable outcome of the move to take human drivers out of the loop.

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> It's not just the developers and the vehicles that need to be secured: the network infrastructure that manages AVs must be too. Control centres will most likely be the primary attack surface for bad actors

What's the solution?

The first step to a solution is admitting there's a problem. When the first demonstrations of security vulnerabilities in vehicles occurred around 2009 and 2010, automakers publicly denied a problem existed. By 2015, that had changed. GM appointed its first chief product cyber security officer, Jeff Massimilla, and began creating a team entirely focused on security within its product development organisation.

Several automakers including Tesla, FCA and GM established responsible disclosure or bug bounty programmes, while others had less formalised processes. Responsible disclosure programmes have proven essential in many industries, such as technology, financial services, and aviation. These programmes provide security researchers like Miller and Valasek a pathway to report any vulnerabilities they discover to the manufacturer before they are disclosed publicly. This gives the manufacturer an opportunity to correct the problem, hopefully before bad actors can exploit it. Increasingly, security researchers that have demonstrated an ability to find vulnerabilities receive job offers from the very companies whose products they infiltrate. Miller and Valasek are now responsible for security engineering at Cruise, the GM subsidiary developing its automated driving system.

Like many other industries, the auto industry formed an information sharing and analysis centre (Auto-ISAC). ISACs provide member companies with an organisation where they can share information about security threats and best practices in a noncompetitive environment. In the auto industry, the challenge with cyber security is the long value chain where potential attacks can happen or vulnerabilities can be implemented. Any given vehicle programme has thousands of engineers working on it, with an ever-increasing number of them focused on software and electronics development.

One of the changes within the industry is the implementation of new development, review, and test processes. Rather than approaching security as an afterthought, it must be designed from the ground up for software and hardware. The new verification tools used to continuously test flaws in the software could be exploited to inject malicious instructions. Access to code repositories must be controlled and changes must be documented, maintaining a chain of trust. That documentation is important for engineers working on the software and for regulatory purposes. In Europe, software is included in the type approval process before vehicles can be sold, as well as for after-sales service. Once a vehicle has received its type approval, any software changes that affect regulated systems must go through an amended type approval process.

> “Ultimately, every honest security expert will admit that it is impossible to absolutely guarantee that any complex system is completely secure. Anyone that says otherwise is lying or deluded. That means that AVs must also be designed to be resilient to attacks

Notably, this has affected Tesla, which pushes out regular and frequent updates to its customers for many features including its Autopilot driver assistance system. Some features distributed to Tesla owners in North America are not available in Europe because Tesla has not submitted them for amended approval. New development tools are becoming available to automate this process of documenting what has changed.

Systems are needed in vehicles to maintain security. With most ECUs now being reprogrammable, it’s crucial to establish that only verified updates are ever applied. A number of suppliers now offer systems for encrypting and

digitally signing software update packages. In the vehicle, the digital signatures must be verified before the updates are applied. Another solution is to continuously check the software against known encryption hashes to make sure it hasn't been tampered with.

Monitoring systems embedded in the vehicle can continuously monitor all of the message traffic across the vehicle network, looking for anomalies that might indicate either an attack or even just an error. When these anomalous messages are detected they can be blocked, the system can go into a fail-safe mode, and the driver or control centre alerted.

AVs will feature levels of redundancy and diversity in the actuation, electronic, and software systems never used in automotive industry before. With no human driver in place to take over if something fails, backup compute platforms are required. AVs will likely be using backups with distinct hardware architecture and software algorithms that execute similar functionality. This can be used as a verification that the primary compute is functioning properly and also to get the vehicle to a safe, minimum-risk condition if a serious problem is detected.

It's not just the developers and the vehicles that need to be secured: the network infrastructure that manages AVs must be too. Control centres will most likely be the primary attack surface for bad actors. Many networks have been breached over the past decade, from banks and manufacturing to retail and movie studios. If attackers found a vulnerability in a remote operation system or a dispatch platform or map updates, it could spread to the entire fleet.

Best practices need to be implemented at every level of the chain when deploying AVs. This includes designing data and control centres for security from the ground up.

Resilience

Ultimately, every honest security expert will admit that it is impossible to absolutely guarantee that any complex system is completely secure. Anyone that says otherwise is lying or deluded. That means that AVs must also be designed to be resilient to attacks. Systems need to be put in place to mitigate the risks if anything goes wrong, because sooner or later it will. Redundant and diverse systems are an important piece of the puzzle. So is constant monitoring and rapid response when issues are detected.

If the industry fails on any of these many fronts, from development to validation to dispatch to updates, it will quickly hamper any enthusiasm that the public and regulators have for AVs. However flawed humans are as drivers, malicious actors rarely take control of them remotely. A hack of a social network, department store, or even a bank is annoying and can be costly, but it's rarely deadly. The same cannot be said of AVs.

As AVs are deployed in the coming years, everyone involved must hope for the best and plan for the worst.

About the author: Sam Abuelsamid is Principal Research Analyst, Guidehouse Insights. He leads the group's E-Mobility Research Service, with a focus on transportation electrification, automated driving and mobility services

INTERVIEW:

Laura Major, Chief Technology Officer, Motional

Jack Hunsley speaks with Motional's CTO to unpack the Hyundai-Aptiv joint venture's vision of the 'perfect robotaxi'

Automakers are eager to expand their portfolios beyond 'just' building cars. With the future of mobility proposing new ownership models, getting in on shared mobility could be critical. It's why Hyundai has leapt into this space alongside autonomous vehicle (AV) developer Aptiv.

Together, Aptiv and Hyundai have formed Motional, a joint venture which will combine Hyundai's automotive reputation with Aptiv's expertise in autonomous driving. The goal: to advance the development and commercialisation of the world's highest-performing and safest automated vehicles.

Reaching this zenith will require Motional to master the robotaxi—a product with which Aptiv is more than familiar, considering the more than 100,000 automated rides it has completed in Las Vegas. To learn more on Motional's robotaxi perspective, however, *Automotive World* sat down with its Chief Technology Officer, Laura Major, to talk artificial intelligence (AI), sensors sets and sanitation.

What different sensor requirements will a robotaxi have compared to a privately-owned AV?

The most important sensors for robotaxi operation are radars, LiDARs and cameras. Each brings a unique ability to autonomous driving and they all complement each other. Radars are essential to identifying moving vehicles at further distances, regardless of the time of day, and are not affected by rain or dust. Meanwhile, cameras excel at identifying and recognising types of objects while LiDAR is best able to identify the size of objects and how far away they are. Each of these sensors is critical for a fully driverless car and must be used in tandem, as these vehicles cannot rely on a human driver as backup and must be robust to failures.

Motional's aim is to advance the development and commercialisation of the world's highest-performing and safest autonomous vehicles.

For a privately-owned autonomous vehicle capable of L4+ driving, the autonomy challenges and required sensor sets will be the same as they are for robotaxis. However, it is important to consider that privately-owned cars are only used for a few hours a day or less, especially compared to robotaxis which run all day, and therefore can use more expensive hardware while still being economical to operate. Privately-owned AVs will either become available much later, once costs are reduced as sensors, computers and software matures, or will start with reduced capabilities, such as an L2 scenario where the driver still supervises the AV, or will only operate for very specific types of roads.

Could we see solid-state LiDAR or LiDAR-less platforms in this space?

Currently, the sensors used in AVs are generally state-of-the-art because autonomy requirements are pushing the limits of what sensors can do. However, these tend to be expensive and need additional work to reach the full automotive-grade seen on cars today and be sustainable for long-term use. As we continue to push the limits of autonomy, tackling problems of snow, heavy rain and other challenges, innovations in sensors, as well as improvements in perception software, will help unlock those more challenging environments and allow AVs to use more cost-effective sensors.

Solid-state LiDAR certainly has promise in reducing cost but comes with its own challenges. As the industry tries to strike the right balance between staying close to hardware developments in LiDAR and looking at emerging work in radar, vision and other sensing methods, this could increasingly close the gaps in capabilities and costs between these different sensing types.

How will a robotaxi interior differ to that of a human-driven taxi? Is there scope for a complete interior redesign?

While robotaxi interiors and exteriors may look similar to those of human-driven taxis for some time, there are hardware changes that must be made to support routine tasks in AVs, such as confirming a rider is getting into the right vehicle or asking a driver to "just pull over here," and deliver a great user experience. In the future, more complete design overhauls could take place and robotaxis could look completely different to human-driven vehicles we see on the roads today as AV technology rethinks and redesigns the way people move.

How important will AI be in enabling that seamless customer experience?

AI will be extremely important to delivering a great, seamless customer experience for riders. Today's taxi drivers deal with many problems through their own methods and hacks, such as navigating crowded pick-up spots. Understanding how and why these processes take place will allow us to leverage AI so a fleet of connected robotaxis can provide a superior customer experience that rivals what we're used to today.

Additionally, AI and machine learning can also be used to improve perception systems, thus improving the technology powering the ride. It could be used to monitor the mood of passengers to help fine-tune their experience, and allow passengers to use voice control for basic commands and touchless interactions.

What sort of day-to-day maintenance will be required to ensure robotaxis meet customer expectations?

To best meet customer demand, operators still play a role in starting and dispatching robotaxis, maintaining traditional automotive systems like tyres and brakes as well as new technology such as sensor calibration and mapping updates, cleaning and sanitising vehicles and supporting the robotaxis if they encounter a situation they cannot handle.

Similarly to how car maintenance intervals have improved over time with enhancements to automated monitoring and maintenance notifications, robotaxi-specific needs such as sensor calibration will continue to improve alongside better fault detection and increased automated recalibration. Sanitisation programmes will also improve as vehicle interior design and hygiene solutions both evolve, allowing for a more effective automated solution as we work towards a touchless rider experience to minimise exposure.

> “Building the perfect robotaxi requires three things: software capabilities, vehicle manufacturing capabilities and significant capital

Generally speaking, what's the secret to making the perfect robotaxi?

Building the perfect robotaxi requires three things: software capabilities, vehicle manufacturing capabilities and significant capital. At Motional, we have all three of these fundamental capabilities, which we believe are essential to success in this industry. Having these three elements allows us to blend our expansive research and automotive DNA to produce a safe, affordable, scalable, best-in-class robotaxi, and ensure our rides still feel comfortable and natural to riders.

Have tech giants beaten automakers to the robotaxi?

It is easy to admire the advances that Silicon Valley's finest have made so far. But is Big Tech ahead of the pack, or just more vocal? By Freddie Holmes

Given the level of investment behind autonomous vehicles (AVs) to date, it is understandable that an air of competition surrounds the sector. Automakers have offered the same basic products for decades, and the chance to completely revolutionise the driving experience will bring more than just bragging rights. For those in Big Tech, the new business models that can be supported by driverless vehicles seem too lucrative to ignore.

And so the race has begun to commercialise a self-driving vehicle. Automakers once envisioned a conventional car that could serve as a private shuttle, but the tech industry has set its sights on shared robotaxis. Automakers have been forced to follow suit or risk losing those potential revenue streams to new entrants. If it is a race, it is unclear exactly who is winning.

Perhaps the most prominent figure in this space is Google, via Waymo. Baidu and Yandex–Chinese and Russian internet giants respectively–also have advanced self-driving vehicle programmes underway. Amazon's recent acquisition of self-driving vehicle developer Zoox has catapulted the e-commerce and consumer electronics giant into the AV game, a space from which it had previously stayed at arm's length. Microsoft and Nvidia have also turned their expertise toward self-driving

computers and silicon chips, while Intel has gone the whole hog and acquired full AV stack expertise and a shared mobility platform. Rumours surrounding Apple's stake in AVs circled for some time before the company officially threw its hat in the ring in 2017, although the details of 'Project Portal' remain sparse.

It is also difficult to define a 'leader' in this space. Just how useful miles and disengagements are in terms of a measure is the subject of debate. Perhaps the scale and reach of public pilots would serve as a better indicator: do more complex environments and longer test routes equate to a more advanced system?

James Hodgson is Principal Analyst at ABI Research's Smart Mobility & Automotive research practice. "Trying to determine who is 'ahead' when it comes to robotaxis can be broken down into two separate questions: who is the most technically proficient, and who has the best-rounded plan for commercialisation?" he said. "Technical proficiency can be judged by looking at who has the best-equipped and most thoroughly validated robotaxi platform, which can drive from A to B safely and smoothly. On the other hand, commercialisation considers who has a roadmap to put this technology on the road, achieve high utilisation rates and realistically recoup some of the enormous investment that has been made."

Google versus Apple

Waymo might seem one of the more obvious front-runners in Big Tech, but it is difficult to conclusively define the Alphabet spin-off as a winner just yet. With regards to technical proficiency and commercial viability, Waymo has proven that the first aspect is hard, and the second is even harder, Hodgson explained.

"Waymo has been uniquely focussed on a robotaxi application for an extremely long time, and is beating much of the competition to the space. It has pioneered new approaches to simulation, and has even developed its own LiDAR designs," said Hodgson. "In addition, it has secured important partnerships with automakers such as Volvo, JLR and FCA. But when robotaxis were put on the road as part of the Waymo One initiative, we saw how difficult it will be to gain traction. It started more with a whimper than a bang."

Waymo One is a paid-for service in Phoenix, Arizona, where members of the public can book a ride like a normal Uber or Lyft. The vehicle drives itself to the destination requested by the rider, but a safety driver remains on board. Waymo also has the Early Rider programme, in which riders can sign up to trial a fully driverless version with no driver behind the wheel. The service met stiff opposition in 2018 following the Uber Advanced Technology Group (ATG) crash in nearby Tempe, where members of the public tried to disrupt or even ram Waymo's test vehicles.

Given the perceived rivalry between Apple and Android, much interest was placed on how Apple might respond to Google's investment in AV technology. Some five years later, industry watchers have been left wondering. "It's only natural that the Google versus Apple rhetoric has spilled over from the mobile space," said Hodgson. "Apple does have the

clout to make a move in this space whenever it wishes, in the same way that Amazon does, but I am not aware of any specific plans it has."

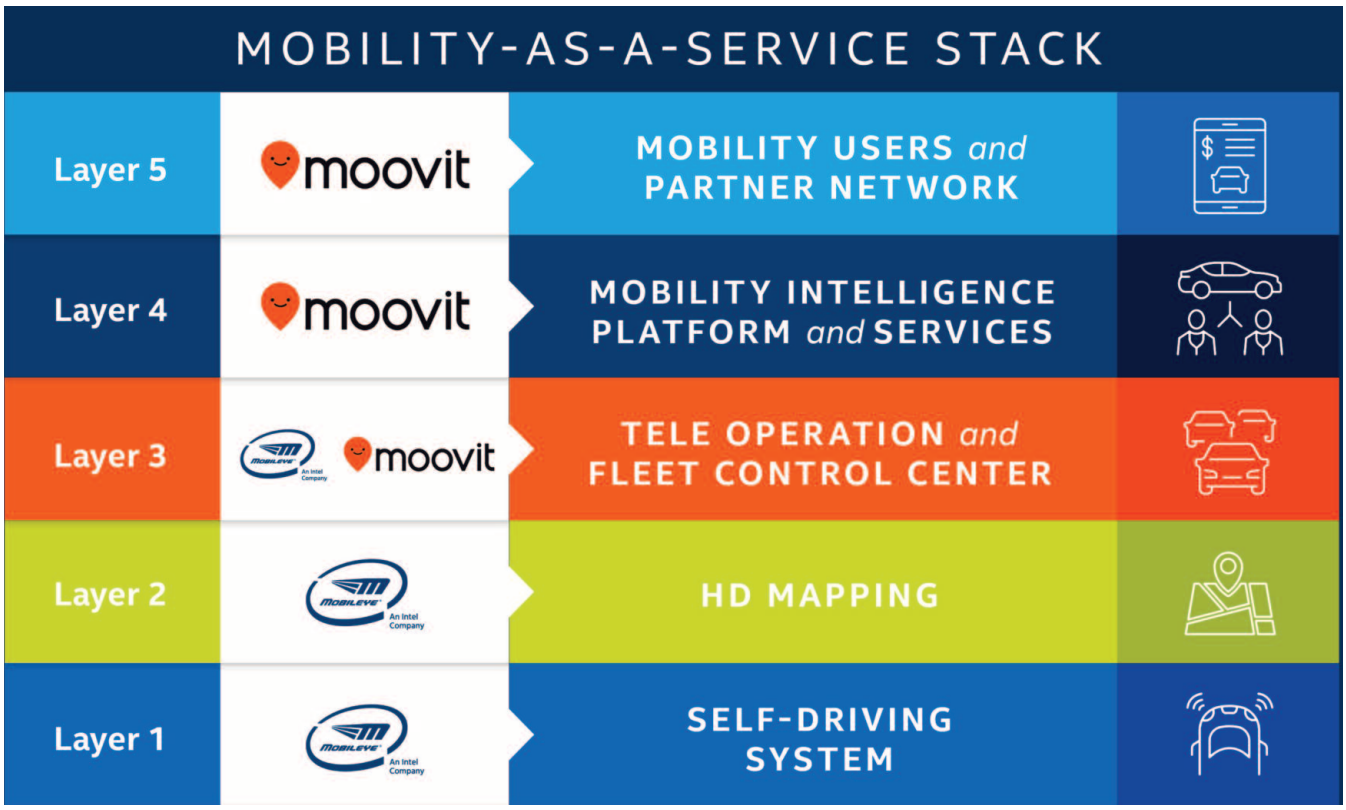
It is difficult to offer anything more than speculation. While there are facts in the public domain—it currently holds an AV testing license in California, and LinkedIn would reveal past employees at 'Project Titan', Apple's self-driving vehicle programme—that's pretty much it. In August, the company hit a US$2tr market valuation, and so despite its limited movements to date, Apple has the backing to avoid the wooden spoon.

IT companies

Somewhat hidden from the spotlight are the IT companies. Intel in particular has long been developing the computing power for self-driving vehicles, but is putting together all that is needed to run a robotaxi. It acquired Mobileye in 2017 to bulk out its self-driving technology, and then Moovit in May 2020 to gain expertise in shared mobility. At some stage, Moovit's technology is expected to underpin a driverless ride-hailing app.

Speaking at Intel's investor summit in November 2019, Amnon Shashua, Chief Executive of Mobileye, underlined the importance of using Mobility as a Service (MaaS) to commercialise robotaxi solutions. "MaaS will govern the pace of self-driving 'productisation', and we want to be ahead of the market here," Shashua said.

In July, Mobileye was awarded a permit by German regulators to test



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Intel's subsidiaries Mobileye and Moovit are pivotal to achieving its robotaxi ambitions

AVs on public streets and Autobahns. Similar tests are also taking place in Tel Aviv and Paris, with the intention of reaching "full commercialisation" in the Israeli city by 2022.

Others such as Microsoft and Nvidia have also bulked out their offering for AV developers, with the latter becoming a pivotal supplier for both established automakers like Mercedes-Benz and Volvo Cars, and start-ups such as Xpeng Motors. These companies do have a stake in the robotaxi race, but are perhaps more focussed on the underlying technology for automated passenger cars.

Delivering goods and people

It is unclear at this stage whether Amazon's acquisition of Zoox could be a long-term play to deploy robotaxis, but as the *Financial Times* reports, those familiar with the deal suggest this could be the case. Driverless delivery services would seem the obvious use case, but Zoox's technology could easily be used to transport people.

"On one hand, you could see Amazon branching out from using autonomous technology for delivery to also using it for personal mobility," said Hodgson. "On the other hand, you could easily imagine a robotaxi operator wanting to expand its portfolio and move into delivery. If you restrict yourself to only one on-demand mobility service, you cut down the opportunities for monetisation."

Uber Eats, for example, has proven so successful that it is now considered part of the company's core business alongside ride-hailing.

Amazon's acquisition of Zoox could be a long-term play to deploy robotaxis

© Amazon

Uber's ATG appears to have made good progress on the robotaxi front, but arguably suffered the industry's most significant setback after a test vehicle struck and killed a pedestrian in March 2018. Ford has also trialled its autonomous test vehicles for both pizza delivery and robotaxi applications. Other examples include Singapore's Grab, which began life as a ride-hailing company but now delivers fast food, groceries and parcels. Jakarta-headquartered Gojek offers a similar array of on-demand services across transportation, food, medicine and parcel deliveries.

There is little clarity as to which players might have a commercially viable solution that can deliver goods and people as yet.

Automakers versus tech giants

From a technology perspective, the automotive industry and its network of suppliers have come together to develop the full AV stacks necessary to support a functional robotaxi. However, the real winners may be those with a profitable consumer-facing business in hand. Commercial viability will rely heavily on utilisation rates, with nearby vehicles readily available at the tap of an app. Compared to the vast networks of taxis, ride-hailing providers, car-sharing services and more, a small fleet of robotaxis may end up gathering dust. Ergo, front-runners in the robotaxi race will be those who are able to rapidly scale-up their fleets.

"Let's say a fleet of 25 robotaxis is operating across London; will a consumer really be happy to wait for a robotaxi when an Uber could arrive in a few minutes?" explained Hodgson. "The question of who is ahead is becoming less a question of technical expertise, and more a question of who has the right partnerships in place to start introducing this technology. It's all about trying to build a go-to-market strategy to actually monetise a robotaxi."

Perhaps a worthwhile question here is whether the AV industry could have come this far without the influence of tech companies and new entrants. The added competition will surely have spurred automakers to investigate robotaxis with greater urgency, but it seems reasonable that advances in the robotaxi have been driven primarily by Big Tech rather than the automotive industry's Big Three.

Could truck platooning be back on the table?

Though interest among some players has cooled, Locomotion and Wilson Logistics are confident in platooning's short term potential. By Jack Hunsley

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Platooning attracted significant early fanfare, but has somewhat fallen by the wayside. Daimler Trucks' change of heart in 2019 tells the story. Though the truckmaker acknowledges that digitally linking multiple trucks has theoretical benefits, initial tests have yielded less than ideal results. "Daimler Trucks has tested platooning for several years, especially in the US, where benefits would be expected to be the most substantial," a 2019 statement read. "Results show that fuel savings, even in perfect platooning conditions, are less than expected and that those savings are further diminished when the platoon gets disconnected and the trucks must accelerate to reconnect." Others, however, remain optimistic.

Locomation

The latest example comes from autonomous driving start-up Locomation. With US-based carrier Wilson Logistics, Locomation is eager to demonstrate that not only could platooning yield the necessary efficiency and economic gains needed for commercial deployment, but that it could do so sooner than later. In August 2020, the two companies announced they had completed 14 trips across a 420-mile route from Portland, Oregan to Nampa, Idaho, covering 3,400 miles across eight days.

"At Locomation we're developing safe and reliable technology for trucks, starting with Autonomous Relay Convoy (ARC) for long haul activities. We believe that properly and safely implemented autonomous convoys will be the first step of improving safety and efficiency of long haul trucking," Locomotion Co-Founder and Chief Executive, Çetin Meriçli, told *Automotive World*. "We're not just a platooning company, we're a self-driving company. Platooning just happens to be the first viable application we see that we can package into a product."

On the outside, its ARC two-truck setup looks similar to other rival solutions, but Locomotion is confident that its product offers something new. "Not all platooning applications are created equal. Though platooning is the broad name the devil is always in the detail," explained Meriçli. "What drew criticism from other industry players early on is those initial platooning concepts had little to no automation and were basically just an advanced version of cruise control. What we're doing is very different from previous platooning applications."

Using the Wilson Logistics pilot as a demonstrator, Locomotion's setup is centred around maximising driving time by deploying drivers in pairs. When the system is engaged, the following driver can disengage completely from the driving task, with this vehicle instead piloted by the lead driver's inputs. "When the system is engaged only one driver will stay on duty and the other will be able to take their rest period while the truck is still moving. That was simply not possible in earlier platooning applications as they only controlled the separation distance between the two trucks, and left control of the steering wheel to individual drivers," Meriçli explained. "The high-level differences of what we are doing is that our product is a form of full autonomy in a very constrained fashion. Traditional platooning is just a version of driver assistance."

Economic gains

Early indications are that the solution could yield significant gains almost across the board. Locomotion, for instance, estimates its technology could yield a 30% reduction in operating costs per mile, including an 8% reduction in fuel consumption for both vehicles. From the fleet perspective, the opportunity to complete driver rest periods while on the go is also highly attractive.

"Our first test from Portland to Nampa is just about one shift for a driver," said Darrell Wilson, Chairman and Chief Executive at Wilson Logistics. "In that shift, those trucks could make the run to Nampa, pick

> "The high-level differences of what we are doing is that our product is a form of full autonomy in a very constrained fashion. Traditional platooning is just a version of driver assistance

Locomotion estimates its technology could yield a 30% reduction in operating costs per mile, including an 8% reduction in fuel consumption per truck

© Locomation

up new loads and then, by swapping the lead truck around at Nampa, both drivers can make it back home within 24 hours. The efficiency of being able to have two loads moving with two drivers is an economical game-changer which will also allow us to introduce serious improvements for the driver experience."

The two companies have already laid out an extensive roadmap. The initial three-year agreement will see Wilson Logistics operate more than 124 ARC-equipped tractors in two-truck convoys across 11 ARC-compatible routes throughout the US. Phase two will then hopefully see more than 1,000 two-truck convoys operating on 68 ARC routes. "We think there are many of these ARC automated lanes that we can identify, and so we hope to start building a network of those in the west and the northwestern US," added Wilson. "That is what we think we can achieve in the next three years and then expand it across the country."

It's certainly an ambitious roadmap, and one with still quite a way to go given that the first phase is set to run until 2023. However, this initial phase could prove to be a handy foundation for more complex solutions and products in future. "We're not going to stop in 2023. We have a pretty expansive road map which starts with autonomous platooning but goes all the way to individual full autonomy," said Meriçli. "That is a very long road and it is going to take quite a bit of time and an extensive amount of testing and validation, so we do not like to talk about timelines all that much, but there will be many more applications."

What do fleets want from the future of trucking?

In a COVID-hit market, truck fleets cannot afford to take their eyes of CASE development. By Wilfried Aulbur and Walter Rentzsch

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Trucking fleets today must manage three main objectives: they need to operate profitably in an increasingly volatile and unpredictable environment, they need to become more sustainable to meet their shareholders' and societal expectations, and they have to offer attractive driver jobs in times of growing driver shortages. Simply clinging to old operating models is unlikely to lead to an acceptable outcome, hence more and more fleets turn to technology such as connected, electric and autonomous trucks as well as the digitalisation of logistics to provide solutions to these pressing problems.

Taking numerous challenges head-on

Trucking fleets need to operate profitably in a largely fragmented market, with a product that is highly commoditised and offers little room for differentiation. Industry margins have historically been low.

As the product of trucking is largely commoditised, most fleets achieve comparable revenue per mile. Optimising cost is key to profitability and requires tight management of key

> "Those that embrace technology trends and build up relevant capability early may have an opportunity to differentiate and earn above-normal returns in the mid-term

As always, the challenge for fleet operators is to differentiate the marketing noise of technology providers from sustainable and profitable business improvements that are enabled by technology. Luckily, the first successful use cases exist and indicate that technology will be able to support the logistics industry in

drivers. First, successful carriers are experts at quickly adapting their fleet composition in volatile market conditions and ensure that they do not have too many assets on their books. They also manage to proactively drive high utilisation of their trucks by dynamic matching of supply and demand. Lastly, they

providing goods to customers in an efficient and sustainable way.

optimise operating cost parameters such as fuel consumption, maintenance and driver costs.

Drivers are a significant cost item which has gone up in recent years due to a systemic driver shortage in most markets. Fleets in the US and Europe have been facing a driver shortage for several years now. China is starting to see the same issue. Besides the availability of drivers, fleets need to worry about driver quality. Attracting and retaining good drivers is a key challenge. Besides attractive pay, fleets try other ways to make the job more attractive, such as by providing more comfort and safety features and working on return to base operations to ensure drivers can be home at night. Driver quality determines not only operational parameters such as fuel efficiency and maintenance cost, it also influences legal costs. The better the driver, the fewer the accidents and the less likeliness of time-consuming and costly litigations.

> “Automation is the trend that is the furthest out but due to its disruptive nature, fleets need to start preparing for it today

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In addition to economic targets, sustainability is increasingly becoming a topic in the industry in all key markets. Logistics is a major driver of GHG emissions and hence in the limelight of both public opinion and regulatory action. For example, in March 2020, the European Commission proposed a law that aims to achieve net-zero GHG emissions by 2050. To achieve the 2050 target, the sales of internal combustion engine (ICE) vehicles would be reduced to a minimum by 2040 and would drive the logistics industry towards either battery-electric or fuel cell vehicles. In the US, California’s new Advanced Clean Trucks (ACT) rule introduces a regulatory push for fleet sustainability as well. China has generally been supportive of battery electric and fuel cell powertrains. However, at present, total cost of ownership (TCO) of alternative powertrains is higher than that of diesel engines for most use cases. Infrastructure availability and changed operating conditions at depots put additional strain on fleet operations. In a price-constrained, commoditised market, fleets must find a way to minimise the cost of running alternative fuel vehicles.

Technology – a necessary means to an end

Strong competition in logistics markets limits the capability of fleets to experiment with technologies for the sake of new technology. New approaches to doing business based on technology must prove that they can enable fleets to provide essential services effectively, safely, reliably and in accordance with the law. Luckily, several technologies are currently able to support fleet operators in their quest to navigate a challenging environment. The key technologies that we will discuss in this article are connectivity, zero-emission powertrains, automation and the digitalization of the logistics space.

It is important to re-emphasise that fleets must take rational business decisions. For example, Camera Monitoring Systems (CMS) have a near-complete penetration in Europe as they are required by law. In the US, penetration for these systems is so far low, as fleets do not see regulatory necessity and economic benefits. By contrast, Automated Manual Transmissions (AMT) drove fuel efficiency improvements in Europe and were a tried technology that jumped from 10% penetration to over 70% penetration for new Class 8 trucks in the US over a short period of five years.

By leveraging artificial intelligence, digital freight matching promises to find additional loads and to reduce empty miles

> Fleets need complete solutions and extensive consulting to deploy larger numbers of eTrucks

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Connected solutions – impacting fleet operations today

New connectivity technologies are enabling a range of service offerings for drivers and fleets in the commercial vehicle space. Solutions like driver scoring, load monitoring and fleet management help improve efficiency, drive cost savings, improve safety and security, reduce downtime, and improve service levels.

While a whole range of solutions is available, they generally have very different maturity levels. Some solutions such as basic asset tracking are mature while services such as predictive maintenance are still emerging.

Fleet adoption of solutions is driven by whether or not the solution addresses clear pain points and integrates seamlessly with existing systems that are already in use. Generally, solutions that are 'a mile deep and an inch wide' are preferred versus solutions that are 'a mile wide and an inch deep'. This means, that fleets are looking for comprehensive approaches to the needs of their specific logistics business. Adoption may require seeding fleets with new technology at a loss to establish positive use cases based on real-life examples.

Digital logistics – a potential driver of efficiency

Digitalisation of logistics happens in many ways. One solution directly relevant for fleets is digital freight matching (DFM). Many startups, but also incumbent players are active in the space. In a simplified manner, DFM generates cost savings through automated supply and demand matching. In principle, this would lead to improved fleet efficiency and utilisation. By leveraging artificial intelligence (AI), DFM promises to find additional loads and to reduce empty miles.

> "Having electric trucks that have a sufficient range, decent TCO and high reliability is not enough for OEMs to be successful in this field

For example, fleets have been cautious to implement camera systems such as forward-looking and driver monitoring systems, in the past. Many drivers saw them as 'spy in the cab'. Once fleet operators saw the benefits, such as availability of relevant footage in case of accident and lawsuits and driver training, adoption sharply increased.

However, the industry has been operating at a constant level of empty miles, for example, in the US, for many years. New technologies such as telematics have not been able to bring about significant improvements in this crucial KPI.

Clearly, widespread adoption of DFM would benefit greatly from proving that the empty run KPIs are significantly improved by employing this new technology.

Going green – where it makes sense

As mentioned earlier, sustainability is a key consideration for the logistics industry. Therefore, it is not surprising that many large fleets are testing electric trucks. In some areas, for example, London, city entry restrictions are a potent motivation to introduce and operate electric vehicles. In other use cases, electric trucks must have a positive TCO versus the diesel alternative to make a relevant dent in fleet asset purchases. Based on TCO considerations, applications of eTrucks will mainly be in local and regional networks, where range requirements result in smaller batteries, and hence lower costs, and the return-to-base character of the operations allows depot charging.

However, having electric trucks that have a sufficient range, decent TCO and high reliability is not enough for OEMs to be successful in this field. Fleets need complete solutions and extensive consulting to deploy larger numbers of eTrucks. Not all use cases and routes are suitable, charging networks both on route and at the depot need to be configured and established, charging cycles need to be optimised to bring down fuel cost, service networks for the eTruck fleet need to be robust. OEMs will only be successful if they work with the right partners and are able to provide a holistic eTruck solution.

Autonomy – tackling several challenges at once

Let's remind ourselves, fleets want to optimise asset utilization, reduce lawsuits and associated costs, reduce operating expenses, improve driver well-being and reduce the negative impact of driver shortage. Autonomous trucking promises to address all these problems which is why we see a high interest in autonomy at present.

With autonomous passenger cars and robotaxis seemingly out of reach due to the complexity of the problem, most OEMs and startups are focusing on providing autonomous solutions in applications such as hub-to-hub or dock-to-dock for the trucking industry. While early market entry timelines by OEMs and startups seemed ambitious, we do believe that we will see a rollout of relevant autonomous solutions by 2025.

While the impact of the other industry trends discussed in this article will largely be evolutionary, automation has the potential to disrupt the industry. Operating cost savings of driverless trucks are unparalleled. Industry implications will be significant and include new operating models, fleet consolidation, a modal shift from rail to road and ultimately new business models such as capacity-as-a-service.

Automation is the trend that is the furthest out but due to its disruptive nature, fleets need to start preparing for it today. Changes that autonomous trucks bring will be fundamental to the way fleets operate.

> Changes that autonomous trucks bring will be fundamental to the way fleets operate

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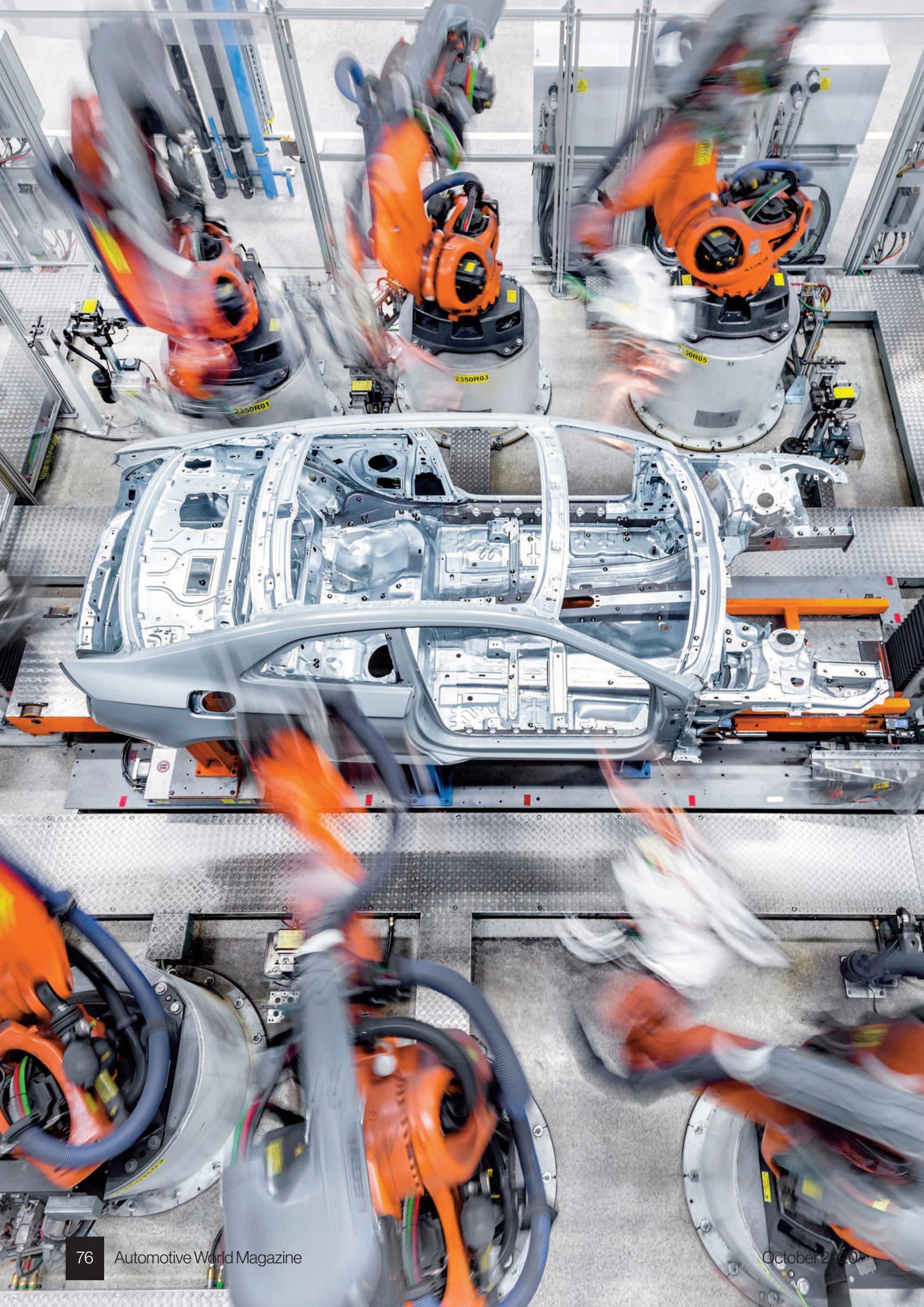
A fleet CEO's agenda

As we have shown in this article, addressing the numerous challenges that fleet CEOs face today requires detailed understanding and intelligent application of new technology. Connectivity and digital logistics are impacting fleet businesses today and need to be integrated in efficient operations. Sustainability will become a question of operating license over the next few years which drives fleets to understand and deploy electrified and potentially fuel cell trucks in their fleet in the short to medium-term. Automation and autonomous trucks are the 800-pound gorilla in terms of industry disruption and must be included in the strategic planning horizon of industry-leading fleets. Fleets have operated in a commoditised environment for a long time with a significant pressure on margins. Those that embrace technology trends and build up relevant capability early may have an opportunity to differentiate and earn above-normal returns in the mid-term.

About the author: Wilfried Aulbur is Senior Partner at Roland Berger and Walter Rentzsch is Principal at Roland Berger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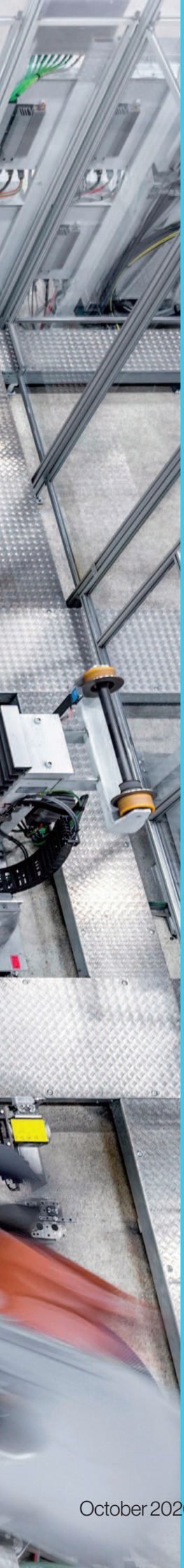

Buyer beware: caution required in Industry 4.0 investments

The smart, connected factory remains greatly appealing for automakers and suppliers, and could prove essential for post-COVID manufacturing. However, companies must tread with care when making investments.
By Xavier Boucherat

Cheaper sensors, improved artificial intelligence (AI) and better software and connectivity have the potential to make factories, their contents and their outputs more visible than ever to manufacturers. This is especially true for automakers and suppliers, which run very lean operations. However, the adoption of Industry 4.0 manufacturing technology remains in its early stages, and is not necessarily straightforward.

Eric Whitley is Senior Account Director at Leading2Lean (L2L), a manufacturing cloud solutions developer that specialises in lean execution. The company works with a number of players in the passenger car and truck manufacturing segments. Speaking to *Automotive World*, he said that whilst Industry 4.0 remains of great interest to automakers and suppliers, there has been a cooling of enthusiasm over the last year.

"What's clear from a technological point of view is that the means to capture data on the shop floor have become very readily available, and manufacturers want to start putting these connected solutions in place," he says. "The issue is, working towards Industry 4.0 can require huge amounts of money for little in the way of return on investment."

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Tread with care

As such, L2L's advice to automakers and suppliers has been to approach Industry 4.0 prudently, and spend money appropriately on areas where returns are guaranteed. The danger, he continues, is that Industry 4.0 remains a nebulous buzzword that lacks strict definition, and just what could become standard practice is far from clear.

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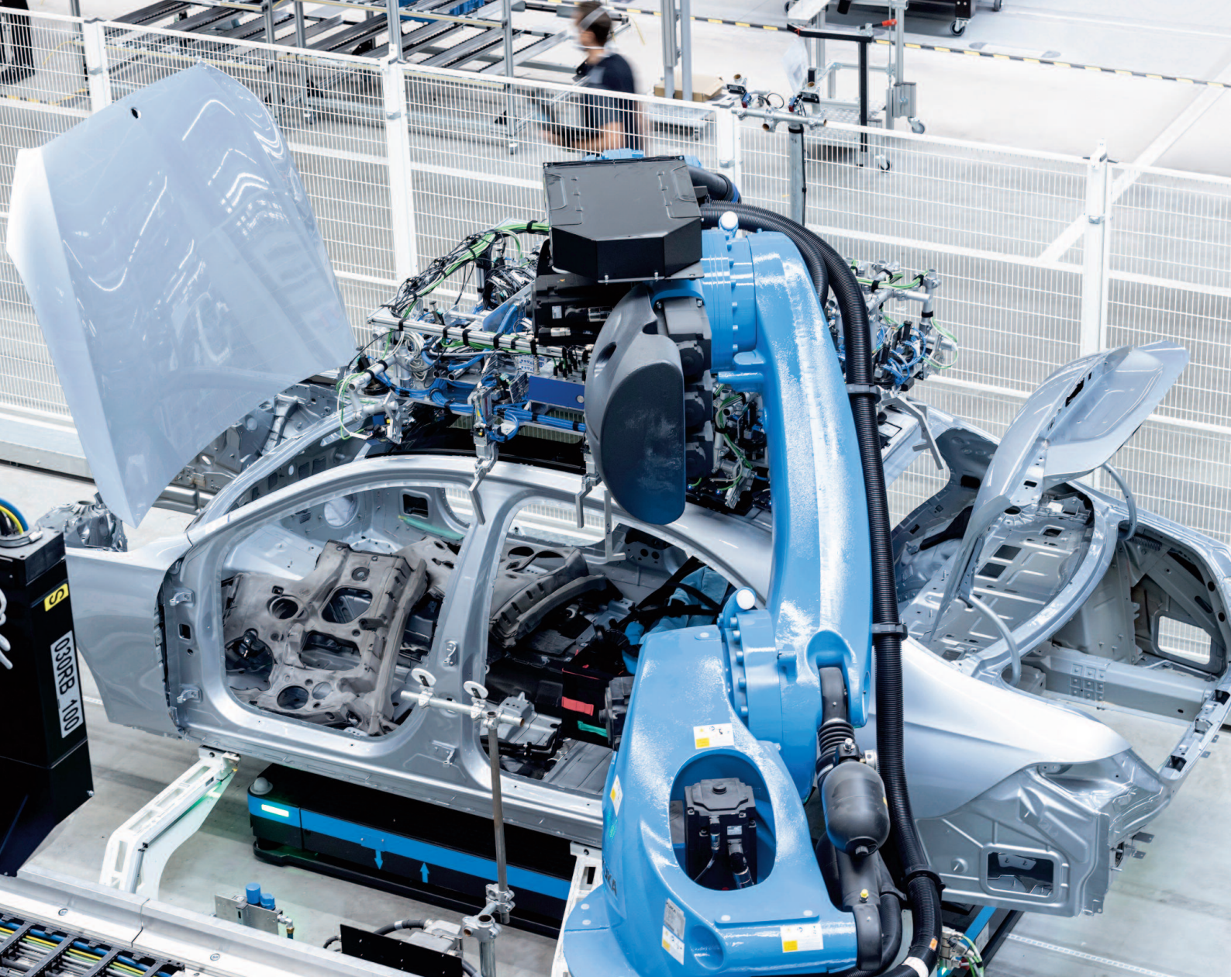

"but for smaller businesses considering fitting sensors to every machine, the costs can quickly run into the millions, and the returns aren't necessarily forthcoming. It can be something of a cultural trap." The arrival of Industry 4.0 could depend in part on the movements of bigger manufacturers, whose solutions could define the standard for other companies.

Along with identifying good opportunities for connected manufacturing, companies will also need to bring their workforce around to the idea that it can deliver improvements. Lean systems are the product of many years of refinement, and incumbent manufacturers will be more than aware of the risks which could accompany changes and disruption. How might veteran engineers be brought around to the enormous benefits which Big Data could deliver?

There are two important things, says Whitley: "First, people have to know that systems are easy to implement, and that they will not prove a burden in terms of how the human processes involved in the work will have to change. Secondly, a new system has to make sense. Manufacturers need to be able to see that by putting something

in place, they'll get a better product or a safer workplace." Ultimately, he adds, new systems and processes have to deliver personal value to workers.

Attitudes differ

Certain companies within automotive are clearly showing more enthusiasm and willingness to connect their factories. For example, says Whitley, Tesla has been a champion of L2L's solutions, using its cloud-based Lean Execution System to transform factory data into meaningful insights and exploring new processes based on this.

"On the flipside of this," he adds, "some more traditional automotive plants are still fighting to move away from paperwork on the shop floor. The concept of removing log books

for spare parts, for example, or for putting preventative maintenance tickets on iPads, is still quite foreign to them." Automakers like Tesla, he says, deserve plaudits for advancing the thought process within the industry.

COVID beater?

COVID-19 remains a fact of life in many markets, and for automakers and suppliers, this means making manufacturing operations safe for employees. The potential impact on productivity ahead of the resumption of business as usual—or something approximating that—is a concern. Research from McKinsey, for example, found that 45% of respondents among manufacturers in Asia had reported sudden materials shortages as a common issue.

Social distancing, remote working and a need for greater transparency mean digitisation of the supply chain is likely to accelerate: players that can pull this off will weather the storm better, writes the company, with a recent survey of manufacturing and supply-chain professionals finding that 90% plan to invest in talent for digitisation. A popular use case has been digital performance management, where pilots at precision-engineering companies have boosted productivity between 40% and 70%.

Industry 4.0 technologies could also help keep humans in the loop at a time when unnecessary travel is frowned upon. Whitley stresses the importance of continued human involvement in manufacturing endeavours, and that any move towards the 'lights out' factory is not necessarily desirable. "Recent years have even seen Tesla, the company that originally floated the lights out factory in automotive, pull back from the idea," he says. "Removing the human element from building and launching vehicles and products is a sad prospect, and whilst it might be possible, it remains a long way out."

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