

## **Industry 4.0 in automotive**

Digitizing the end-to-end  
automotive value chain

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future of mobility?**

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## Insights



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# Foreword

The automotive industry is undergoing massive transformation. It's pervasive across the industry and much of it is being driven by Industry 4.0 and the continued digitization of the entire value chain.

Industry 4.0 has both expanded the possibilities of digital transformation in automotive and increased its importance to original equipment manufacturers (OEMs), suppliers, dealers, captive finance organizations, and others working in the mobility ecosystem.

By harnessing the power of combined and connected digital and physical technologies—artificial intelligence, the Internet of Things, additive manufacturing, robotics, cloud computing, and others—companies throughout the value chain are becoming more flexible, efficient, and responsive, and reshaping how they operate their businesses, engage customers, and deliver products and services.

Deloitte has studied several facets of Industry 4.0, examining the impact, opportunities, and potential pitfalls organizations could encounter as they digitally transform their businesses. Whether building a cognitive digital supply network, digitizing product management, developing Industry 4.0 capabilities through collaborations with startups, or scaling up anything as-a-service, the research available through Deloitte Insights has helped inform executives leading digital transformation.

To help automotive executives navigate these exciting and transformative times, Deloitte has collaborated with *Automotive News* and other companies, new and old, to delve into how Industry 4.0 is changing the automotive industry and demonstrate how some enterprises are using these technologies to speed design and manufacturing, improve quality, and enhance how they protect their enterprises, products, business partners, and customers.

We also reveal the results of our 2020 Global Automotive Consumer Study, examining how consumers around the world feel about autonomy, connectivity and electric vehicles; whom they trust to bring these digital and physical technologies to market; and how willing they are to pay a premium for automakers' investments in advanced automotive technologies.

We hope you find the insights on the following pages helpful to you and your organizations. Our global Automotive practice stands ready to help and advise OEMs, suppliers, dealers, and others working in the business of moving people and goods.

**Joseph Vitale, Jr.**

Global Automotive practice leader, Deloitte

**Craig Giffi**

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Global managing principal, Deloitte Insights





## Who's going to pay for the future of mobility?

Insights from Deloitte's 2020 Global Automotive Consumer Study

To encourage consumer uptake of advanced vehicle technologies, the automotive ecosystem still has some work to do, including figuring out just who will build and pay for electric vehicle charging infrastructure.

By Craig A. Giffi, Joseph Vitale Jr., Thomas Schiller, and Ryan Robinson

**S**TAKEHOLDERS UP AND down the automotive value chain are pumping in billions of dollars into making connected, autonomous, shared, and electric vehicles (EVs) a reality. In today's climate, most automakers are so concerned about being left behind, they're frantically trying to keep multiple research and development (R&D) balls in the air at the same time. But the cost of juggling multiple

programs is enormous, and trying to do it at a time when most industry analysts agree that the sales upcycle the industry has enjoyed for a decade is all but exhausted is next to impossible.

High R&D costs are one likely reason some automakers have recently posted softer financial results<sup>1</sup>, and they may also be prompting automakers

toward cost-cutting measures, such as rationalizing their global manufacturing footprints. Further, high R&D costs could explain, at least in part, why some manufacturers are contemplating their exit from entire vehicle categories, as shedding unprofitable segments would allow automakers to spread their R&D budgets a bit further among those that remain.

Another way automakers are seeking to control rising R&D costs is by actively looking to acquire technical expertise rather than developing it in-house. Some original equipment manufacturers (OEMs) recognize that developing advanced technologies themselves would take far too long and yield less than successful results. Accordingly, many automakers are intensifying efforts to pursue technology startups in global automotive innovation hubs, such as Israel.

Yet another approach is to forge strategic partnerships to spread the cost—and risk—of developing advanced technologies across a greater number of players. Indeed, some OEMs are trying to plug visible gaps in their R&D programs by leveraging expertise from rival companies. The number of such partnerships is growing daily, challenging the traditional concept of competitive positioning. In fact, some recent headlines suggest that the rise in partnerships to pool technical expertise may be a precursor to renewed industry consolidation.<sup>2</sup> Along with this, some automakers, especially those that have been slow to get in the advanced technologies game, may undertake significant rationalization efforts—particularly in their supply base—as they come under increasing pressure to remain relevant.

## You can build it, but will they come?

Underlying automakers' massive R&D investments is the assumption that consumers will actually pay for these advanced technologies when they appear on the

market. However, results from the 2020 Deloitte Global Automotive Consumer Study suggest that achieving a return on invested capital for new technologies may be more difficult than some automakers think.

Consider the curious case of the autonomous vehicle (AV). Three years ago, media headlines and industry stakeholders were tripping over each other to herald the imminent arrival of commercially viable AV fleets. But since then, the projected timeline for the first commercial AV launch has moved further and further back, with some industry observers now wondering if it will ever happen.<sup>3</sup> More to the point of this article, results from our automotive consumer survey suggest that consumer interest in AVs has stalled. In last year's survey, just under half of respondents in several countries believed that AV technology will not be safe,<sup>4</sup> and this year's results paint a very similar picture. Except in India and China, where the percentage of people that think autonomous vehicles will not be safe has actually gone back up. What's more, this year's survey found that most consumers in Germany (67 percent) and Japan (61 percent) are not willing to pay more than approximately US\$500 extra for AV technology (figure 1).

This unwillingness to pay for AV technology is part and parcel of a more general lack of willingness among consumers in developed economies to spend extra for other types of advanced automotive features. For instance, close to half of the survey respondents in Germany, and a respectable fraction of those in the United States (31 percent) and Japan (28 percent), indicated they would not pay more for a vehicle that could communicate with other vehicles and with road infrastructure to improve safety. That said, unwillingness to pay extra for connectivity was much lower among consumers in India (6 percent) and China (5 percent). This may be because consumers in more mature automotive markets have been trained for many years to expect manufacturers to introduce

FIGURE 1

### Even as OEMs continue to spend billions on R&D for advanced vehicle features, questions remain about consumers' willingness to pay for them

Percentage of consumers who are *unwilling* to pay more than ~US\$500\* for a vehicle with advanced technologies

Advanced technology category	Germany	United States	Japan	Republic of Korea	China	India
Safety	71%	60%	59%	52%	39%	49%
Connectivity	79%	66%	72%	63%	46%	52%
Infotainment	84%	75%	79%	74%	52%	57%
Autonomy	67%	58%	61%	42%	37%	40%
Alternative engine solutions	58%	54%	60%	42%	37%	39%
Unwilling to pay more than ...	€400	US\$500	¥50,000	₩500,000	¥2,500	₹25,000

\*Calculated for each country in local market currency (roughly equivalent to US\$500).  
Source: 2020 Deloitte Global Automotive Consumer Study.

advanced technologies at little or no additional cost as a way to differentiate themselves in the market. In developing countries, where a much larger proportion of consumers are first-time vehicle owners, similar expectations about how vehicles are equipped may not have had a chance to solidify.

The story is roughly similar when it comes to advanced powertrain technologies. Fifty-eight percent of German survey respondents said they would not pay roughly the equivalent of US\$500 extra for a vehicle with an alternative-fuel engine; 54 percent of consumers in the United States said likewise. On the other hand, only 37 percent of Chinese survey respondents said they would not pay more than about US\$500 extra for an alternative powertrain, likely reflecting the significant growth in China's new-energy vehicle market over the last few years. But even so, Chinese consumers' interest in

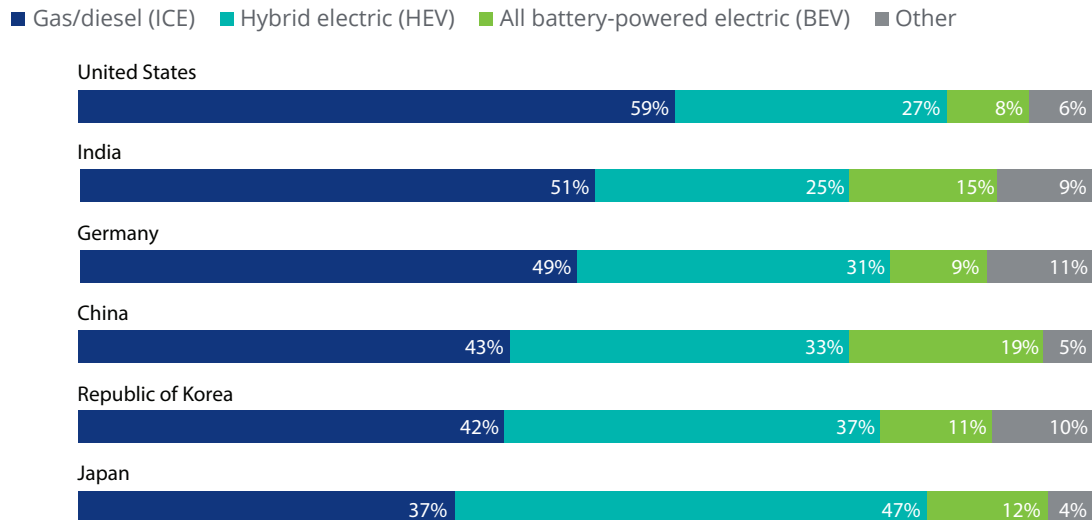
alternative-fuel vehicles may be starting to wane, perhaps in response to the government's decision to pull back on incentives.<sup>5</sup> Only 57 percent of this year's Chinese respondents said that they would most want something other than a traditional gasoline or diesel-powered vehicle in their next vehicle (figure 2), down from 65 percent in 2019.

Automakers still have reason to invest in developing new powertrain technologies, however. Interest in alternative-fuel vehicles is rising in several other markets. Fifty-eight percent of consumers in the Republic of Korea said they would most prefer their next vehicle to have an alternative fuel engine, up from 43 percent in 2019. Fifty-one percent of respondents in Germany said the same, up from 37 percent a year ago. Even in the United States, where a combination of loose environmental policy, low fuel prices, and tight incentives have kept interest in

FIGURE 2

## Consumer interest in alternative-fuel engines varies across countries

Consumer preferences for their next vehicle's powertrain



Note: "Other" category includes ethanol, compressed natural gas, and hydrogen fuel cells.  
Source: 2020 Deloitte Global Automotive Consumer Study.

hybrid and fully electric vehicles largely at bay, 41 percent of consumers said they are actively considering an alternative-fuel vehicle in the future, up from only 29 percent last year.

### EV charging infrastructure: *Someone needs to own it*

For EVs to really take off, consumers should be convinced that they won't be left at the side of the road with a dead battery. Range anxiety and the availability of charging infrastructure are two of the top three concerns holding people in many countries back from purchasing an EV—even though these fears are becoming less justified as the technology improves with every passing year.

EV technology has progressed to the point where an EV's battery capacity would satisfy the vast majority

of consumers' actual transportation requirements. In fact, our study results show that even though 41 percent of US consumers believe full battery electric vehicles should have a range of at least 300 miles, the average vehicle owner travels just over 27 miles per day. However, in the absence of large, exogenous factors such as a fuel price shock, a shift in government policy or incentives, or even a diesel scandal, getting consumers over their collective fears regarding EVs remains difficult. It doesn't help that EV manufacturers and infrastructure providers face the "chicken and egg" problem of whether to encourage demand by installing charging infrastructure first, or wait until after demand has risen to a certain point before investing significantly in a charging network.

However, the biggest problem may be that no one in the automotive ecosystem seems especially eager to take responsibility for the kind of holistic charging

infrastructure investments that will likely be required. Some vehicle manufacturers have stated that they are not in the business of selling fuel, although some pioneers have been forced into the charging space to make their overall business strategy viable. For their part, traditional fossil fuel providers are happy to maintain the status quo. Government agencies are channeling some funds to specific projects to promote innovation, but these amounts are nowhere near the overall investment likely needed.

When put to consumers, the question of who should be responsible for EV charging infrastructure becomes somewhat clearer. Thirty-eight percent of consumers in Japan believe that it is the EV manufacturer's obligation to build out the necessary charging network, and many in the United States (36 percent) and India (34 percent) hold the same view. However, opinions in the Republic of Korea and Germany are decidedly different. In the Republic of Korea, only 24 percent of consumers said that the OEM should be responsible for building charging stations, and half thought it should be the government's responsibility. Moreover, German consumers were roughly evenly split in placing the responsibility on OEMs, government, existing fuel companies, and electric utilities. As we've seen in some other industries, the question of establishing a viable, holistic EV charging network may open the door to a public-private partnership (P3) that would have the resources to scale an appropriate response to this issue.<sup>6</sup>

An interesting side note is that, when asked how long it should take to fully charge an EV, only 17 percent of German consumers said less than 10 minutes. In fact, less than 10 percent of US survey respondents said

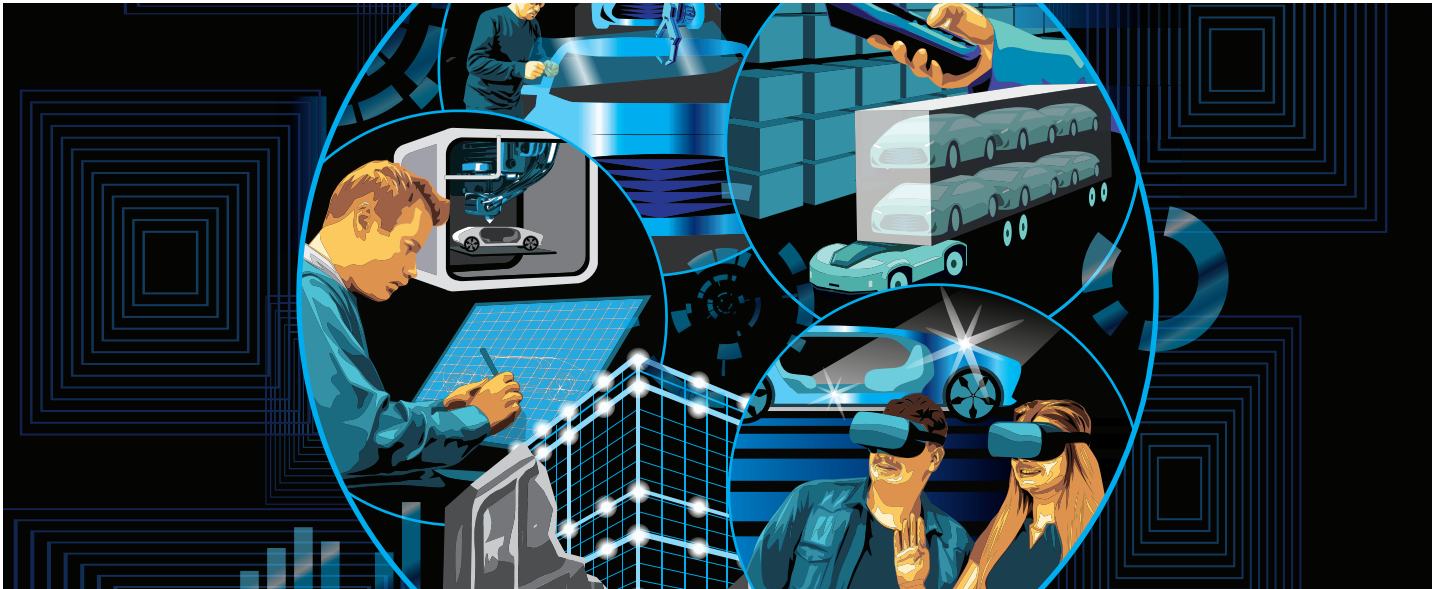
the same. Further, 27 percent of US respondents and 30 percent of German consumers would be willing to wait between 30 minutes and one hour to charge their electric car.

## What about fuel taxes in an EV world?

To date, one of EVs' most compelling benefits has been essentially free or very low-cost fuel. But governments, of course, have an interest in maintaining the considerable revenue stream currently generated by fossil fuel taxes. In fact, the level of refueling taxes applied in Germany (46 percent), Japan (47 percent), and India (49 percent), have translated into a substantial and stable source of government revenue over several decades. Even in the US, a loss of the 19 percent tax applied to each gallon of gas pumped would be a considerable gap to backfill. Therefore, the more that global governments encourage EV ownership through incentives and other stimulants, the more they should figure out how to either tax electricity to earn revenue comparable to that generated by fossil fuel taxes, or come up with alternative revenue sources to fill the void. These alternatives could take the form of user fees or other, similar mechanisms, but many of these ideas are very unpopular with consumers.<sup>7</sup>

At the end of the day, both automakers and governments should find new revenue streams to fill potential gaps left by an evolving industry. Even though some of the technologies now being developed may take years to become commercially available, considering the implications now may yield significant benefits down the road.





## Steering into Industry 4.0 in the automotive sector

Taking advantage of uncertain times to align for future success

To remain relevant in the Industry 4.0 ecosystem, automotive companies have to clear some near-term hurdles and have an integrated organizational approach toward technology and innovation.

By Debanjan Dutt, Vijay Natarajan, Alexander Wilson, and Ryan Robinson

**O**VER THE PAST 50 years, the automotive sector has invested billions of dollars in enterprise systems, automation solutions, and advanced product technologies. Nonetheless, in some aspects, automotive companies remain a slow follower to data and technology companies that are defining the competitive landscape of the Fourth

Industrial Revolution—Industry 4.0. These technology companies have developed low-cost computing, high-speed connectivity, and machine learning that have enabled the digitization of the physical world, transforming insights into optimized actions. Now, these well-capitalized tech players are entering the automotive sector, and traditional

automakers—saddled with legacy infrastructures and product portfolios—are struggling to keep pace.

Technologies causing wholesale transformation of the global automotive sector are commonly called the CASE (connectivity, autonomy, shared mobility, and electrification) technologies. While each technology has started to affect the sector in many ways, their convergence, in the backdrop of looming macroeconomic headwinds, will likely have a tectonic impact on the global automotive value chain. It also means that over the next two decades, it is entirely plausible that some undercapitalized global original equipment manufacturers (OEMs) will fall behind the technology innovation curve. These players could be swallowed by larger players or simply close their doors. Suppliers won't have it any easier as they've taken on more and more of the responsibility to innovate. In fact, suppliers with product portfolios tied to traditional technologies currently being disrupted could well find themselves with unmarketable assets and skill sets. Therefore, to remain relevant in the face of rapid technology development, companies across the automotive ecosystem are investing heavily in product and manufacturing process innovation.

## Buying the technology to stay relevant ...

Automotive players aim to future-proof themselves through strategic partnerships and targeted mergers and acquisitions. Some are looking to competitors for opportunities to shore up gaps in their technology portfolio. Others are harvesting the fertile landscapes of global innovation hubs such as Israel,<sup>1</sup> identifying startups to affect meaningful change across the organization. Yet other companies are looking to digital transformation initiatives to drive efficiencies through their manufacturing processes, investing heavily in technology solutions, including smart

factories, cobotics, digital supply networks, artificial intelligence, predictive maintenance, and blockchain. Even some of the CASE technologies are causing companies to think carefully about how they manufacture vehicles going forward. For example, vehicle electrification likely entails a simpler manufacturing process.<sup>2</sup>

However, focusing on these technological solutions in isolation may not be enough as thriving in a new global automotive industry reality will likely require a willingness to reinvent all the aspects of the business, including the product offering, the business model, manufacturing process, and the customer experience. Individual or conditional technological fixes are not an alternative to a long-term technology strategy. Solving individual challenges only partially delivers on the full value proposition of Industry 4.0. *It's only when these digital technologies are combined with an integrated organizational design can they truly lead to transformational gain.*

## ... but technology by itself is not enough

To succeed in the innovation era, automotive companies will likely need to harness a variety of advanced technologies. In the Industry 4.0 ecosystem, the primary enabler is often data that plays out in the form of a digital twin and digital thread. A digital twin is a near-real-time digital duplicate of every physical object—be it raw material, shipping containers, plant tooling, or the work-in-process flowing down the assembly line—or process and helps optimize business performance.<sup>3</sup> Separate from the digital twin is the digital thread, which links together all the events experienced throughout the life cycle of a product.

Digital throughput across the entire value chain and life cycle generates tons of data in real time, which

when deciphered can be invaluable to a wide variety of stakeholders. Companies that are successful at *capturing and analyzing the data and information* can unlock exponential growth opportunities to accelerate along the innovation curve. However, this journey isn't without challenges.

## Overcome key challenges

Many of the systems underpinning Industry 4.0 applications are proprietary and can present integration challenges. Peer consortiums, industry associations, and government bodies are all currently working to establish sets of standards, sometimes even competing sets, with no clarity on which will prevail. Interestingly, not all challenges start at the advanced digital technology stage. Individual companies also face a number of *fundamental challenges* that threaten their ability to even think about embarking on a journey to implement digital solutions.

While *lean management* principles have been popularized by Japanese automotive manufacturers, not every automotive company has taken full advantage of their potential value. The primary foundation of the lean philosophy is the continuous identification and elimination of nonvalue-added waste through targeted problem-solving and standardized processes. Lean principles can be applied throughout the value chain, from R&D through marketing, and even when thinking about the cost, time, and effort to implement advanced digital solutions.

Manufacturing companies also face a *shortage of talent* to plan, execute, and maintain new digital systems. The number of engineers trained in handling

unstructured data and big-data tools—crucial for the type and scale of data generated by digital twins and digital threads—is gradually increasing, but still falls far short of anticipated demand. The challenge extends to the shop floor as well. In fact, one of our recent studies forecasts a growing shortage of skilled workers over the next decade—up to as many as 2.4 million unfilled jobs between 2018 and 2028, which could put US\$2 trillion of economic output at risk.<sup>4</sup>

Leading automotive companies already have teams experimenting with certain advanced technologies and data. However, these efforts are often hampered by *archaic corporate procedures*. Removing such obstacles to properly evaluate and scale forward-looking digital pilots is imperative, but it can only be achieved with appropriate sponsorship and governance. In other words, the right approach to transformational change needs to be applied in a holistic manner to realize the maximum value of digital technologies.

Tackling a small problem first is a time-tested way to begin a transformational technology journey. Small successes can serve as proof points, leading to a greater willingness to take a chance on more substantive investments. By *starting small and moving quickly*, organizations can generate success stories that prove the value and importance of the full transformation. That said, the quickest way of ending any emergent transformation is the company's inability to articulate its value to management, investors, and employees. As companies officially stand-up transformation programs, the right determinants for success need to be established, tracked, and tied back to the core enterprise value propositions and growth drivers. Finally, as successful pilots are scaled, value attainment should be assessed, and the rollouts modified accordingly.

## Key questions companies should be asking

In order to align with the Industry 4.0 paradigm and take advantage of turbulent times in the automotive sector, company boards and senior executives should be considering the following key questions.

### WHICH ADVANCED INNOVATIONS WILL IMPACT THE AUTO INDUSTRY THE MOST OVER THE NEXT DECADE?

Although it is impossible to exactly predict the future, there are several innovation signposts coming into view that will have a dramatic effect on the industry and a company's positioning within it. Performing a critical assessment of necessary innovation capabilities and aligning with industry trends should be a top priority for management.

### WHAT WILL FUTURE CUSTOMERS DEMAND?

The customer of the future will likely be more technologically demanding and may seek more than just a traditional automotive experience. Taking a step back to refresh your perspective on what customers want would inform critical decisions regarding the right data and infrastructure needed to offer new, digitally enabled services. It could even spur the development of game-changing innovations or new business models.

### DO I HAVE THE RIGHT TALENT TO FULFILL FUTURE EXPECTATIONS?

Any wholesale Industry 4.0 transformation undertaken will likely force management to rethink the company's strategy on several issues, including talent acquisition and development. However, identifying the right skill set and hiring the right talent to drive new growth will likely remain a key challenge. Therefore, companies might need to invest to upskill existing employees, but doing so will likely necessitate sustained investment on both internal and external fronts.

### HOW SHOULD I FUND THE INVESTMENTS NEEDED?

As part of an Industry 4.0 capability assessment, management teams will likely identify pools of excess spend that are misaligned to the overall future vision of the company. To be in the best financial position to invest in a wide-ranging digital transformation, an overarching operational fitness program could free up cash while serving as a great test bed to pilot use cases within manufacturing and other high-cost functions. Likewise, boards can explore the divestiture of underperforming assets while market valuations remain high.





# Cyber everywhere: Preparing for automotive safety in the face of cyber threats

An executive interview with GM's Jeff Massimilla

The success of the interconnected automotive ecosystem may hinge on cybersecurity. GM's Jeff Massimilla speaks about what the company is doing to protect its operations, vehicles, and consumers from cyber threats, and how the industry is moving forward in its pursuit of cyber safety.

By Tom McGinnis, Tom Haberman, Steve Schmith, and Ryan Robinson

IN TODAY'S CONNECTED world, cyber is everywhere. This is particularly true in the automotive sector, where advanced, connected technologies are producing unprecedented disruption in almost every aspect of the automotive ecosystem,

including manufacturing and supply chain, consumer engagement, connected and autonomous vehicles, dealer interactions, financing and, of course, enterprise operations.

With disruption often comes wide-ranging cyber risks for the automotive ecosystem. Cyberattacks can breach data, privacy, and safety; disrupt operations and compromise coveted intellectual property; cause financial losses; and dilute consumer trust in a brand. These are daunting challenges—but they also open up interesting opportunities. To gain insight on how automakers are approaching “cyber everywhere,” we sat down with General Motors’ (GM) vice president of global cybersecurity, Jeff Massimilla, to understand what GM is doing from an enterprise and product perspective to mitigate cyber risk.

**DELOITTE:** How would you describe “cyber everywhere” in the automotive industry and how has it evolved over the past five years?

**JEFF MASSIMILLA:** The very concept of “cyber everywhere” has evolved greatly over the past five years. Earlier, it focused just on information technology systems, with the aim to prevent the loss of intellectual property. Even then, GM had a somewhat broader definition than other companies because of OnStar.<sup>1</sup> Today, however, cyber

manufacturing environment, the most recent evolution of cyber everywhere across most industries. Insulating manufacturing from disruption, while protecting employees and product integrity, is all very important now. As a result, our cybersecurity organization is involved in every aspect of GM’s business.

**DELOITTE:** How can automotive companies promote external collaboration to address cyber risks?

**JM:** Collaborations, whether within or outside of the automotive industry, are extremely important to understanding different solutions, and sharing this knowledge is critical in addressing the rapidly evolving cyber threat landscape. We collaborate with several industries including medical devices, aerospace and defense, and consumer electronics. The point of these relationships is to exchange knowledge and expertise around the key challenges in connected ecosystems. In the automotive industry, we have two very specific collaboration initiatives. The first is the US Auto Information Sharing and Analysis Center (Auto-ISAC), which allows us to collaborate within a competitive industry. It encourages meaningful interactions among automotive companies with varying levels of cyber maturity. It provides a safe, trusted environment for participants to create best practices for the entire industry. The second critical piece is related to supply chain security—we work closely with our partner suppliers to ensure the integrity, security, and quality of our products. Collaboration presents some challenges too, with the main one being forming a *collaboration mentality* across the ecosystem, so that everyone is working together to mitigate the risks of cyber incursion.

**DELOITTE:** How do you navigate the threat of cyber risk to your business operations and products when you work with partners that might be operating in less mature cyber environments?

**“Understanding the different solutions and sharing knowledge across the industry are critical to address the rapidly evolving cyber threat landscape.”**

everywhere is truly an end-to-end connected ecosystem, from the back office through the telecom carriers and down to the platform itself, enabling automated driving and convenience features, mobile hotspots, and so on. GM still has an information security function, but it has evolved to be highly focused on data privacy. Focus has also moved to the

**JM:** Over the past few years, awareness of cybersecurity, as it applies to safety and privacy in the automotive industry, has skyrocketed. Regulation is not far behind either—the California Consumer Privacy Act, Europe’s General Data Protection Regulation, various privacy regulations in South America, and regulatory activities on this front in China. The importance of having a strong cyber posture across these global markets cannot be overstated. Closer to home, at GM, cyber is a key priority and I’m impressed with, and appreciative of, GM’s leadership in establishing maturity around cyber. GM’s strong focus on cyber emanates from the CEO and her senior leadership team. We also have a cybersecurity committee within our board of directors. I truly believe that is the foundation for driving maturity in this space. Additionally, we try to share everything we can to bring the entire industry up, rather than compete on cyber. After all, cyber has to be done correctly, so that there is no risk to our customers or products.

**“We try to share everything we can to bring the entire industry up, rather than compete on cyber.”**

**DELOITTE:** What sets GM apart in terms of its approach to cyber everywhere?

**JM:** There are varying levels of maturity among companies operating both within and outside the automotive space. Certainly, several organizations take it very seriously. There are also companies in the middle and some that have not prioritized cyber as an operational imperative. Large companies like us, that have the ability to attract the best cyber talent, have a responsibility to provide expertise, best practices, and tangible solutions to help smaller companies that struggle to get the right talent.

**DELOITTE:** Overall, how would you rank the industry’s preparedness for the challenges of cyber today and how well do you think the industry is prepared for cyberattacks?

**JM:** The Auto-ISAC is foundational to the cyber preparedness of the auto industry and establishing trust among competing organizations. For example, if a major cyberattack puts customer safety at risk, we would tap into the Auto-ISAC structure to share updates and discuss mitigation strategies in real time because customer safety is most important in our industry. In addition, the Auto-ISAC is uniquely positioned to facilitate proactive incident-response exercises. We do this within our company all the time, but to do it as an industry—interacting with other stakeholders in the event of a cyber incident—is another level of preparedness.

**DELOITTE:** How is GM bringing consumers along in this cyber journey?

**JM:** We recognize that the increasing level of autonomy in vehicles can make cybersecurity a fundamental concern for our consumers. Yet in our experience, consumers don’t necessarily equate increasing vehicle connectivity with cybersecurity risk. Further, although data privacy is a concern, consumers may relate that more to the data and devices they bring into the vehicle. All that being said, we believe that overall consumer behavior and good cyber hygiene are a critical part of our ability to keep our consumers safe. For example, bringing a compromised smartphone into the vehicle could be problematic from a cybersecurity perspective. Therefore, we develop our products assuming that brought-in devices are already compromised and that consumers may be doing things in the vehicle that they should not be doing. As such, we develop our defensive posture with the central pillars of privacy and safety in mind.



Jeff Massimilla

**DELOITTE:** What should car companies be prioritizing and what do you think are the most important things that need to happen to be successful in an evolving cyber ecosystem?

**JM:** Cyber is a rapidly evolving landscape and we certainly don't have all the answers, but we're focused and learning every day. First, cyber has to be a

*Read our [interview with GM's Mandi Damman](#), chief engineer of the autonomous vehicle program, to learn about how GM is bringing consumers along to build trust in self-driving and other advanced automotive technologies.*

board-level priority, a CEO priority, and a priority within each function of the business because our industry is so interconnected. So, a top-down mandate will set the wheels rolling. Second, filling the massive talent gap in the industry is imperative for long-term success. The automotive industry and GM are competing with some of the most high-tech companies out there, including those in Silicon Valley. Overcoming the talent shortage by working with universities, government agencies, and other stakeholders is something the industry needs to do to be successful in the long run. Finally, it is incumbent upon larger companies to be proactive in helping the industry, so companies that do not have a similar ability to do everything on their own can have access to the knowledge and solutions that make the entire system stronger.

Cyber is a national security challenge and it is important to focus on it from an overall perspective. After all, you are only as strong as the weakest link in your ecosystem.

**DELOITTE:** How can companies achieve and accelerate top-down support from the board and senior executives?

**“The automotive industry and GM are competing with some of the most high-tech companies out there, including those in Silicon Valley.”**



**JM:** Company leaders have to show openness toward cybersecurity and an appetite for risk management. Their mutual willingness to do so is equally important. I think it also starts with the relationships being built among companies at the board, CEO, or cyber leader level. If those relationships exist, cross-pollination of ideas can occur. At GM, we are very interested in the whole industry moving forward together.

**DELOITTE:** Finally, do you have any thoughts on the key messages required to articulate the business case for top-down support?

**JM:** In today's digitally connected world, cybersecurity must be one of the top risks for any technology-dependent and forward-thinking company. The ramifications of a single cyber event could be catastrophic. So, recognizing the cyber risk and deploying the right mindset and resources are paramount. It's almost like having a permanent, post-breach mentality.

*Editor's note: GM recently announced that Jeff Massimilla has been appointed to lead General Motors' Global Connected Ecosystem Integration group.*

*Stay tuned for our interview with GM's Kevin Tierney as we delve deeper into what the company is doing to protect its vehicles, consumers, and others from cyber threats.*

*Mr. Massimilla's participation in this article is solely for educational purposes based on his knowledge of the subject, and the views expressed by him are solely his own.*

## Israel: Advancing the automotive sector in the Fourth Industrial Revolution



*By Lotan Levkowitz, partner, Grove Ventures and Yariv Lotan, head of strategic sector development, Startup Nation Central*

As manufacturing goes digital, automotive companies seeking to form strong, transformative, and reliable Industry 4.0 partnerships may do well to look to Israel for opportunities. The country has more than 240 Industry 4.0 startups—the second most in the world—with robust technical capabilities in a wide range of disciplines, including cybersecurity, operations optimization, platforms and connectivity, sensing and imaging, supply chain, maintenance, additive manufacturing, inspection, and testing. And they have access to funding opportunities, with the government committed to investing the equivalent of US\$68.5 million between 2017 and 2021,<sup>1</sup> and venture capitalists (VC) pumping more than US\$6 billion in 2018 alone.<sup>2</sup>

Many Israeli startups have major automotive companies as partners and customers, including Ford, Volkswagen, Porsche, Faurecia, and Lear Corporation. Moreover, the Israel's innovation hub' significant impact on the global automotive sector is showcased by well-recognized success stories such as Mobileye, bought by Intel for US\$15.3 billion, and Waze, acquired by Google for more than US\$1 billion.<sup>3</sup>

How can automotive companies engage Israeli startups?

- **Define a precise business problem.** Automakers should start by defining the exact business challenges they would like to solve. Then, they can appoint a champion to lead manufacturing digital transformation and help Israeli startups develop and apply the right tech capability to the production environment.
- **Map out pilot projects.** Israeli startups that have brought value to multiple automotive companies globally, such as Claroty, 3DSignals, and Inspekto, started their journeys with well-defined pilot projects. It is recommended that, before diving into a new alliance, companies clearly define proof-of-value processes, onboarding processes, and key performance indicators.
- **Develop a local presence.** A local partner, such as a current ecosystem player, accelerator, or VC, can help large multinational automotive companies bridge the gap between their culture and the pace and the attitude of emerging startups. For example, Porsche established a local entity—Porsche Digital Lab Tel Aviv—that assists it in scouting and interacting with cutting-edge Israeli startups.

In short, the Israeli Innovation Valley is at the forefront of creating technologies that can allow for a safer, cleaner, and more efficient mobility experience. Companies looking to gain a competitive advantage in the rapidly evolving global automotive landscape would do well to better understand the potential benefits that Israeli startups can offer.

## Using automotive data for prediction, monitoring, detection, and response

# Upstream

*By Dan Sahar, vice president, Upstream Security*

Connectivity is all around us—in vehicles, processes, business models, and even customers—and the data it generates is at the very core of Industry 4.0. In the case of connected vehicles, nearly every component and action, whether vehicle sensors, telematics servers, application services, or mobile apps, generates data. A vast amount of offline data, such as warranty information, vehicle service histories, and recall information, can also be used to augment real-time information.

The ability to leverage this data allows for monitoring, prediction, and timely and effective response mechanisms. In other words, *data can help a variety of stakeholders predict and mitigate threats*. For example, when it comes to vehicle maintenance, data can be used to discover anomalies and predict malfunctions before they occur, avoiding costly repairs and services. The benefits of predictive data analysis can go even further, allowing companies to design unique service offerings for either individual vehicles or fleets, or to optimize maintenance operations and parts inventories.

On the security front, early detection and response make all the difference. Automotive data can be used to uncover breach attempts as well as to detect vehicle and component usage outliers. Real-time identification of data anomalies can help mitigate threats using predefined procedures before widespread damage can take place.

In order to unlock the value in automotive data, companies would be well-served to consider the following steps:

1. Start with deploying a unified data platform designed to ingest various types of proprietary data sets. It should also be able to anonymize, normalize, and enrich the data, thereby enabling the creation of value-added applications.
2. Use machine learning to create digital models of communications, context, and behaviors, and to establish a baseline of normal vehicle and service operations.
3. Use pattern recognition technologies to detect early signs of faults, failures, and security risks, and identify baseline outliers and anomalies across parameters.
4. Tailor what constitutes an anomaly for each stakeholder to enable appropriate handling based on the root cause.
5. Finally, deploy a variety of solutions, ranging from preemptively replacing parts to simply sending coupons for battery replacement at participating service stations.

Unifying automotive data in a single platform can allow OEMs and connected fleets to optimize their vehicles and improve customer service while improving safety, security, and continuity.

## Pursuing “Zero Defects” in automotive electronics



*By Oreste Donzella and Janay Camp, KLA Corporation*

Innovations in electrification, connectivity, and autonomous driving capabilities are driving a revolution in automotive electronics—and in the semiconductor components at their core. From a few hundred semiconductor devices a decade ago, a modern vehicle may now contain up to 8,000 semiconductor ICs (integrated circuits)<sup>1</sup> integrated into complex electronics subsystems that can represent 20–30 percent, or even more, of the vehicle’s cost.<sup>2</sup>

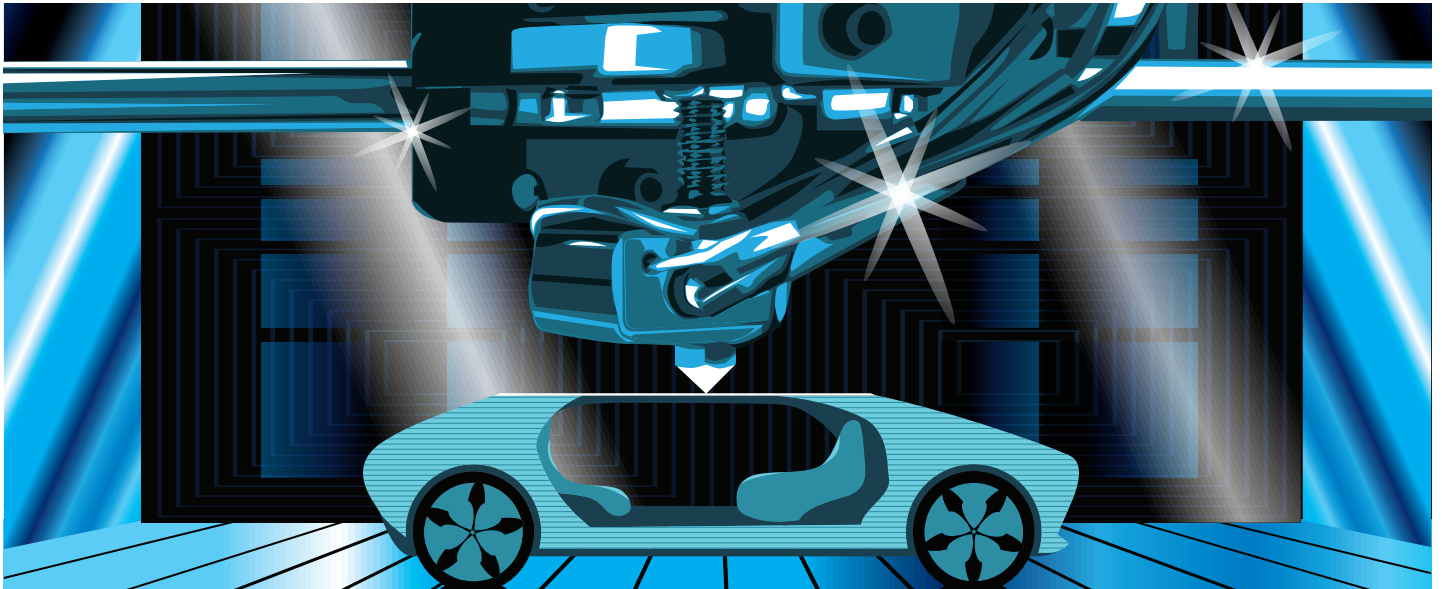
Because electronics are currently the number one failure item in cars less than three years old,<sup>3</sup> improving their reliability can help car manufacturers control warranty costs and avoid expensive liabilities. Semiconductor ICs are also essential to safety-critical features such as advanced driver assistance systems (ADAS). Hence, car manufacturers and Tier 1 suppliers are raising the bar for their electronics’ quality and reliability, requiring parts-per-billion (ppb) failure rates and pushing the “Zero Defects” concept into their electronics supply chains.

Critical to improving electronic systems’ reliability is to eliminate latent reliability defects in their semiconductor components. Latent reliability defects are defects that, because of their size or location on a chip, do not cause an electrical failure when the chip is tested. As a result, the at-risk chip passes the electrical test and “escapes” into the supply chain. Once the chip is installed, latent reliability defects can be “activated” under conditions considered extreme for semiconductor devices, such as intense cold, high heat, high humidity, and vibration—all of which frequently arise during normal vehicle operation.

Detecting latent reliability defects thus requires new approaches that do not rely solely on traditional electrical testing methods. Automotive semiconductor manufacturers have traditionally used statistical analyses of electrical test data to detect potential outlier chips that pass with marginal performance.<sup>4</sup> This method is often reinforced with screening methods that inspect every chip being manufactured at several critical points in the process. A limitation of such comprehensive screening, however, is that not all defects detected may affect real-world reliability. A conservative approach to removing these defects can result in an unacceptable level of “overkill”—the removal of chips that would have functioned normally throughout their specified life.

Machine learning-based methods can help more accurately identify which defects may actually cause failures. The Inline Defect Part Average Testing (I-PAT™) method, for instance, leverages inline defect inspection, historical reliability knowledge, and data from electrical wafer sorting, burn-in, final tests, and field returns to develop a neural network model that can minimize potential “escapes” and reduce overkill.<sup>5</sup> Multiple semiconductor fabs are evaluating the I-PAT™ methodology, with promising preliminary results. Going forward, this and similar techniques will be pivotal in helping semiconductor manufacturers achieve the quality levels needed for safe, reliable vehicle operation.





## Driving differentiated value with additive manufacturing

Additive manufacturing is an opportunity to differentiate via unique designs and economy of production.

By Kevin Quinn

Director, additive design and manufacturing, General Motors

*Based on an interview with Deloitte's Christopher Ongena, Kellen Smetana, and Ryan Robinson*

GENERAL MOTORS (GM) has used additive manufacturing (AM) technology, operationally known as 3D printing, to produce component prototypes for three decades. This unique manufacturing process afforded us the ability to rapidly produce prototype parts and iterate much quicker than would normally be possible through lengthy, traditional manufacturing processes. Until recently, the aim of the additive approach was simply to support the component development

process by finding and addressing part design issues prior to the manufacturing of production tools.

Now, GM is actively investing to develop AM capabilities as we see an opportunity to drive differentiated value in many ways. Two key areas stand out. First, AM can help make lightweight versions of many nonvisible, structural components. Lightweighting is vital to meet fuel-economy regulations and achieve longer ranges for our electric

vehicles. Second, AM can deliver more flexibility to make unique designs.

From a business standpoint, prototyping physical parts is very costly, so the more we can do to validate a component in the digital space, the more we can control our costs. We obviously must maintain robust physical validation capabilities to ensure performance requirements are met, but there are huge benefits from being able to do some of the work upfront using digital tools.

In fact, we can simulate all input parameters for a given component before we print it. In this way, we're able to better set the conditions for success because we may only have to print a small number of iterations to get it fully dialed in prior to production.

## Unlocking the potential benefits

In terms of implementing AM solutions, there are four key considerations: cost, throughput, postprocessing requirements, and material availability. Additive cost models can change the paradigm with the simple realization that you don't have to first build a tool anymore; you can go straight to building the part. The cost-benefit extends even further as unlike tools—that are typically built to support a five-year vehicle life cycle plus additional service part production—we can *reuse the same AM printer across multiple vehicle programs* and design generations.

As a manufacturer, it is a very compelling value proposition to think that you can now amortize the cost of tooling over a much wider volume and longer period. Achieving this leverage model is an important goal, as some industry estimates suggest that AM can increase the piece cost of making some parts versus using traditional methods by a factor of 10 to 100.

The time saved is also a critical benefit. Even if we're targeting low-volume production runs, we cannot have a build process that takes too long. Therefore, reducing the time it takes to manufacture a part with faster printers and more efficient processes is a key objective. Also important is the "box size," or the part density we can achieve within the usable printing volume, so that we are never printing just one part at a time.

The accuracy of the build process is the next benefit. Every time we need to alter a component in a postprocess environment, it adds to the overall cost. Getting the execution right in the initial build process can reduce the number of postprocessing steps, thereby cost.

Finally, we must consider the materials used in AM. There are opportunities to utilize both printed metals and plastics for the parts that make up our vehicles and the tools that produce the components. More material development must be done to enable the full suite of automotive-grade 3D printed materials that our industry requires. For example, the 3D printing industry has developed exotic metal powders, such as titanium and nickel base alloys, for the aerospace and medical industries. The automotive industry does not use many of these materials in production, so we need more development and focus on steel and aluminum to meet our specific needs.

## Bringing parts manufacturing to the final assembly line

Parts production currently entails a complicated system of logistics connecting a multitude of tiered suppliers constantly shipping components back and forth across the manufacturing ecosystem. AM could minimize waste and downtime in this process by printing more components on location at the final vehicle assembly facility. While having an AM

footprint on-site in all our manufacturing locations would help in this regard, there are cases where it doesn't always provide an optimal solution.

Sometimes we need more than just the machine that makes the part, as some components also require testing and analysis equipment. For this reason, we think the best approach is to *embark on the AM journey with our suppliers, encouraging them to evolve with this new technology* because of its potential transformative benefits for the entire ecosystem.

Having said that, one of the biggest practical challenges to implementing AM across multiple stakeholders in a manufacturing value chain is *cybersecurity*. The central question is: How do we ensure that both our physical manufacturing processes and underlying intellectual property assets remain secure when a breach on either front could result in catastrophic consequences?

Other AM benefits can occur further downstream in the manufacturing process. For example, instead of producing and warehousing large inventories of service parts, AM helps us envision a warehouse of printers producing parts on demand. Going a step further, we can potentially leverage our manufacturing network so that we could fully utilize idle printer capacity in a given plant when printers in a different plant are oversubscribed.

## Driving the technology with the right talent

To integrate AM into our organization, we put together a team of additive design and manufacturing professionals who have the technical ability of simulation engineers, the creativity of designers, as well as expertise in the 3D printing process. Over the

From an overall standpoint, industry estimates suggest there are approximately US\$165 billion of tooling assets in North America alone dedicated to service part production. This puts a significant burden on the supply base for tooling maintenance and introduces an inherent risk of production downtime as the knowledge required to run these machines often resides in relatively few resources. Overall, converting from traditional production processes to additive manufacturing could free up a significant amount of capacity in the supply base.

— Christopher Ongena,  
Additive Manufacturing  
practice leader, Deloitte LLP

past two years, they've been focused on producing new, unique designs for components that are difficult or impossible to manufacture using traditional production methods.

This team is also working with software tools that enable capabilities to support this initiative. Historically, designers optimized existing parts, resulting in derivative design options with incremental gains in areas such as mass reduction and/or production efficiency. Tools using topology optimization and generative design principles, by contrast, can generate hundreds of different design options in the same amount of time, with performance requirements built-in upfront. This provides us more confidence in our design solutions meeting critical performance requirements, while dramatically increasing our ability to optimize the end product.

## Change is never easy, but it is essential

One of the most important issues we tackle every day is *change* itself. AM represents a completely new way of doing things and it has the capacity to affect a wide variety of areas within the organization, so it's pertinent that we have the buy-in of our people. From purchasing and cost estimates to design conversations and the shop floor, we are asking people to think a long way out of their comfort zone.

*We have to push ourselves to think differently, or we'll never get better.* We're also working on some AM solutions that we expect will establish how thinking differently can yield better results.

We've installed several printers at our plants to produce specialized tools. However, just as we've had to convince our design engineers of the value of AM, we also have to demonstrate the value of AM to the employees on the line. To accomplish this, we've been running workshops with our plant staff to build advocates for the technology.

Creating advocates and, ultimately, adoption in additive manufacturing technology can often be more work than companies initially anticipate. Having said that, creating repositories of success stories, training

material, and hands-on experience with the tools needed to be successful on the shop floor are critical in achieving the buy-in needed to push the technology forward.

## What's ahead for additive manufacturing?

To move the automotive industry forward on AM, there must be more of a collective effort beyond what the OEMs can accomplish on their own. There needs to be an ecosystem approach involving everyone from the manufacturers and tier-one integrators to the tool shops, material suppliers, software developers, and next-gen machine makers.

We will have to work together to accelerate collective AM capabilities, establishing and communicating a consistent set of needs for the automotive industry. It is certainly going to be an interesting journey to scale this technology, but I'm confident we can get there.

~

*Thanks to Deloitte's **Christopher Ongena**, **Kellen Smetana**, and **Ryan Robinson** for their contributions to this article.*



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