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The state of the auto industry and the shift to electric vehicles

The automotive industry is experiencing a level of change not seen since Henry Ford revolutionized automotive production with the assembly line.

Since then, the industry has been dominated by the internal combustion engine (ICE). Today, ICE vehicles make up roughly 90% of all cars sold. But the remaining 10%, comprised chiefly of electric vehicles (EVs), is the cause of change. As recently as 2019, EVs represented only 2.5% of global car sales; three years later, that number almost quadrupled to 9%, with no signs of slowing down.[1] Quite the opposite. Government pressure, consumer preferences, and corporate and environmental sustainability concerns have spiked interest in EVs.

OEMs are taking notice and acting accordingly. Incumbents like EV manufacturer Tesla are seeing rapid growth in volumes (Q1-22 sales for Tesla were 67% greater than last year[2]), but the traditional OEMs are also kicking EV production into gear. Ford will spend $50bn over the next five years to enable its vision of producing 2mn EVs by 2026. Not to be outdone, GM will invest $35bn by 2035 to move entirely to EVs and stop selling ICE vehicles.[3] Similarly, luxury automaker BMW has plans for 50% of its vehicles sold to be EVs by 2030.[4] Aside from the entrenched players, new entrants like Rivian and Lucid are positioning themselves as potential competitors not just to all-EV OEMs like Tesla but to the ICE incumbents looking to switch to EVs.

[1] https://www.iea.org/commentaries/electric-cars-fend-off-supply-challenges-to-more-than-double-global-sales

[2] https://www.cnbc.com/2022/04/02/tesla-tsla-q1-2022-vehicle-production-and-delivery-numbers.html

[3] https://fortune.com/2021/11/16/general-motors-gm-electric-vehicles-2035-tesla-volkswagen/#:~:text=General%20Motors%20said%20it%20would,and%20the%20entire%20auto%20industry.

[4] https://www.ttnews.com/articles/bmw-ramps-move-electric-cars

The shift to EV's at a glance

$50bn+
pending on EV's over next 5 years

0
Anticipated ICE vehicles sold in 2035

50%
Expected % EV sales will make of total sales by 2030

TOYOTA

3.5bn
EV's on the road by 2030

25+
New EV models planned to launch in the US by 2030

The implications of this shift are massive. While there are numerous business, political, and socio-economic impacts to consider, this industry report explores the impact this shift to EVs has on the automotive supply chain and, more precisely, on the planning function within OEMs and suppliers. The following pages will dive deeper into the supply chain implications of this shift; discuss the required tech infrastructure that must be in place to mitigate risk and future-proof supply chains; identify core planning capabilities needed to ensure a smooth transition to EVs, and discuss the impact this shift has on people and processes.

In this industry report we will discuss:

- Supply chain implications of the shift to EV's, specifically as it relate to supply chain planning
- The required tech infrastructure that must be in place to mitigate risk and future-proof the supply chain systems
- Required planning capabilities needed to ensure EV's are planned for effectively with optimal service and minimal waste
- The impact on people and processes which must be accounted for to ensure all changes "stick"

A simpler vehicle leading to chaotic implications

While it can be tempting to think of EVs as regular cars that happen to be electric, EVs are mechanically less complex than their ICE counterparts. According to PwC[5], "EVs are radically simpler in mechanical terms...The UBS Group compared the Chevrolet Bolt's engine to a four-cylinder internal-combustion engine and found that the electric motor had three moving parts, compared to the ICE's 113." The aforementioned **rapid growth affects** both OEMs and suppliers in many ways, but four implications in particular stick out: the management of new demand signals; the introduction of new value chains; the management of capacities; and the integration of this shift with Environmental, Social, and Governance (ESG) targets.

Buyers of EVs aren't just car buyers who happened to **choose something different.** Given the increased price tag, differentiated (for the most part) product designs, and environmental statement of purchasing an EV, proper care and diligence must be taken to understand these customers, especially in this early phase. Where possible, OEMs must understand which markets are buying which types of EVs and ensure that the right products are available in these regions at the right times and that marketing dollars are allocated accordingly. What's more, OEMs must keep their ear to the ground to identify any market-shifting trends and respond accordingly before the competition.

The shift to EVs means new value chains must **be mapped, understood, and managed.** The ongoing semiconductor shortage illustrates that specific components can grind the $3 trillion auto industry to a screeching halt. The chip shortage exposed just how deep and complex certain value chains were and how difficult they could be to manage when a crisis hit. Some OEMs were scrambling to map out the different Tier-1,2, and 3 suppliers to fully understand their connectivity and the subsequent impact on vehicle production.

[5] https://www.pwc.com/us/en/industries/industrial-products/library/electric-vehicles-supply-chain.html

This new emphasis on new components such as the lithium-ion battery means new suppliers and value chains for OEMs to manage and new competition for existing suppliers.

EVs introduce even more **critical value chains that must be managed,** most notably the lithium-ion battery. According to that same PwC article, this is even more complicated because these batteries "are primarily made by companies outside the traditional auto supply chain."

Alongside introducing new value chains is the **need to manage the transition of production and sales capacity** from ICE vehicles to those required for EVs. According to a recent McKinsey study[6], 90% of suppliers are reshaping their portfolios to be more aligned with EV production (e.g., e-motors, batteries). Similarly, EV-specific components are expected to make up 42% of all vehicle components by 2030, compared to only 9% today. With this shift will come new competition and thus more suppliers to manage, especially in the transition period where EV demand is ramping up while ICE volumes remain the majority. For OEMs, this presents a planning nightmare; dealing with the current supplier landscape is difficult enough as is, but adding in new components with new suppliers (some of whom are new entrants) to manage means already strained information systems may be pushed beyond their limits. New competitors will make life even more challenging for suppliers as existing incumbents attempt to update their portfolios while continuing to produce ICE components.

[6] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/amid-disruption-automotive-suppliers-must-reimagine-their-footprints

Four critical impications of the shift to EV's

1. New demand signals

New demand signals must be ingested, translated, and acted upon with speed and precision

2. New value chains

New value chains will be introduced (e.g., lithium-ion batteries) and must be managed, including visibility into tier-n suppliers

3. New capacities

New capacities must be onboarded and others winded down as EV components will go from 9% of all components to 42%

4. New regulatory pressures

New regulatory pressures will emerge as governments and consumers carefully monitor the sustainability implications of the new EV's

Finally, this shift to EVs will come with corresponding expectations from regulators and consumers for auto companies **to reduce emissions and improve the overall sustainability** of their operations. Today, most companies have put ESG targets in place. But far fewer are putting in measures to reach these goals. In the same McKinsey survey, 83% of auto suppliers have defined sustainability targets, but only 7% are starting to implement tangible carbon emissions-abatement programs. Once the pendulum shifts and EVs fully "arrive," auto companies will have to take concrete steps to ensure that the operations behind these EVs and their components are as sustainable as the product produced.

How to respond with resilience

Three components must be present to respond to the shift to EV's effectively

1. Modern tech stack

Modern tech stack leveraging knowledge graph tech, external demand signals, and the cloud

2. Modern digital planning capabilities

Modern digital planning capabilities to adequately sense and forecast demand, manage capacities, scenario plan effectively, and track ESG targets

3. Modern operating model

Modern operating model to ensure processes are optimized and employees are upskilled to thrive in the new normal

Automotive companies must ensure that their supply chain planning operations can account for these variables while also "future-proofing" for any future shocks (e.g., another chip shortage). To do this, OEMs and suppliers must ensure their tech stack, planning capabilities, and people/processes are optimized for this new reality. From a tech standpoint, a solution must have the requisite technical architecture to handle all the new inputs and extend as needed to incorporate additional variables.

From there, analytics and planning workflows must be used to manage capacities, identify risks, quantify their impact, and mitigate said risks collaboratively. Finally, processes must be optimized and digital capabilities built to drive a robust and sustainable impact.

Tomorrow's problems can't be solved using yesterday's technology

Doing things the way they've always been done is rarely the answer. This means that the technology of yesterday (OLAP architectures, "Columns and Rows" tables connected by never-ending Joins and SQL Queries) must be leveraged selectively. It also means that companies must implement next-generation technology (knowledge graphs, GraphCube technology, machine learning) at scale to traverse the vast volumes of data effectively while maintaining a level of performance that's acceptable by today's standards.

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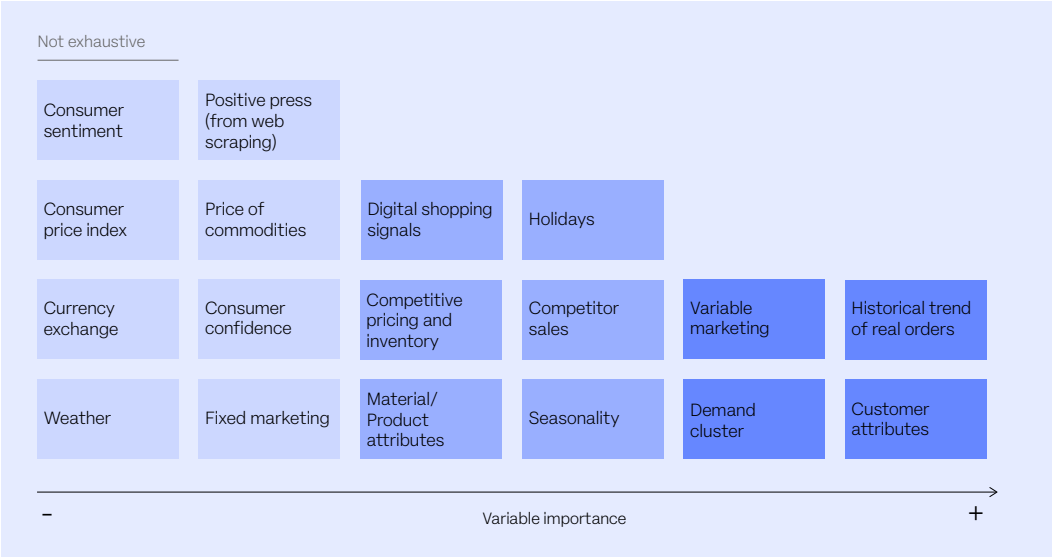
Knowledge graph technology could be one solution to help planning organizations respond to rapidly-shifting market conditions with agility and resilience. Unlike traditional data architecture, knowledge graphs model business relationships as they are (rather than as connections between an endless array of relational tables), **allowing complexity to be harnessed and performance to be optimized**.

This o9 whitepaper on future-proofing supply chains with knowledge graphs goes into more detail on the topic. The implication is that value chains must be modeled as they are and traced back to N-tiers of the supply chain to understand the impact that a lithium mine shutdown could have on an OEMs ability to meet consumer demand. Additionally, data can be loaded more frequently (e.g., daily loads for a Control Tower) and leveraged for more rapid decision-making due to the advanced knowledge graph architecture.

With a knowledge graph, automotive companies can unlock another critical puzzle piece: leveraging external data feeds. **Leveraging third-party data can be extremely useful** in sensing risks and forecasting consumer demand; a previous o9 whitepaper discussed the former. Traditional forecasting has relied on historical data to predict future demand. The inherent flaw is that what happened yesterday doesn't always align with what's happening today or what will happen tomorrow. One prominent example is COVID: many large companies saw significant dips in demand in early to mid-2020. Using this dip to forecast future sales would artificially deflate the forecast, leading to potential missed orders and unhappy customers (or worse, in the case of pharmaceutical companies).

Leveraging external data signals, combined with machine learning algorithms, is an alternate way to forecast and a potential key differentiator for automotive companies. By understanding the impact of key demand drivers on sales, auto companies can leverage machine learning to ingest the forecast for these drivers and **create a demand plan based on what will happen rather than what has happened.** While there is more to the demand planning process, the first step is to be able to ingest publicly available external drivers of demand. Knowledge graphs take this data and model the relationships to the actual business due to their ability to handle large volumes of data and enable machine learning to help make sense of it.

Potential external demand drivers relevant to forecasting OEM demand



Finally, leveraging the cloud is essential from a technology standpoint. Much has been said about the benefits of cloud technology, and many automotive companies are investing heavily in this space. With that said, this innovation must continue, especially in the supply chain space. As mentioned in this Accenture article[7], cloud use for supply chain shouldn't just be focused on cost savings. Applications should be built and deployed on the cloud, leveraging the resources and innovation of cloud providers. Additionally, the cloud can be leveraged to access various data (such as third-party inputs) to increase visibility. The benefits are clear: surveyed executives indicated that the cloud has helped them increase resilience (52% of surveyed executives) and sustainability (48%) as well as **improve forecast accuracy by 26%,** reduce supply chain operating costs by 16%, and increase revenue and profitability by 5%**.**

[7] https://www.accenture.com/us-en/insights/supply-chain-operations/supply-chain-transformation-cloud#:~:text=What%20are%20the%20benefits%20of,speed%2C%20agility%2C%20and%20scale

Planning capabilities that match the innovative vehicles they're planning for

With the proper technology stack in place, supply chain planning capabilities must be improved and scaled to ensure the right product is at the right place at the right time. Doing this will require rethinking and optimizing the capabilities for demand planning, capacity management, service parts planning, scenario planning, and managing ESG goals.

To maximize the benefits of the shift to EVs, automotive companies must improve the overall quality of their demand plan. As mentioned earlier, doing this requires shifting from predictions based on historical data to forecasts **leveraging external drivers** of demand and their forecasted value**.** Enabling this requires the proper architecture that can natively ingest large volumes of publicly available information (mentioned earlier in this document) and the analytical know-how to determine which drivers matter most and create a forecasting model around these relationships.

One *o9* client, a Tier-1 automotive supplier, sought to leverage machine learning models to improve the quality of the OEM forecast. To achieve this, they used the *o9* platform to ingest third-party data (macroeconomic data, steel prices, IHS data, promotions, etc.) and created a machine-learning driver-based forecasting model that helped **improve forecast accuracy by ten percentage points** while improving planner productivity and automating non-value-added tasks. Another client in the Consumer-Packaged Goods (CPG) industry—an industry that is the leader in leveraging this technology for demand forecasting—built a machine-learning model based on trade promotions, weather, competitor pricing, and their internal marketing initiatives. As a result, demand forecast accuracy **improved by eight percentage points** on an already highly-accurate figure.

Capacity management will be another critical planning capability for automotive companies. Tier-1 suppliers building ICE and EV products will have to manage multiple finished goods (FGs), their different assembly capacities, and supplier capacities. Many of these suppliers will be brand new, so time-phased visibility into **approved Average and Max weekly production** will be critical. Ideally, the FG constrained supply plan will automatically account for

Two o9 clients who got it right with AI/ML forecasting

$10bn+ Tier-1 auto supplier

The pain

- High variability in quality and accuracy of OEM demand
- External data not leveraged for forecasting
- Existing planning system (SAP APO) insufficient

The solution

- Automatic consolidation and analysis of OEM forecast
- Use of external data providers (e.g., IHS) to calculate take rates for different parts
- Machine-learning driver-based models used to more accurately forecast demand

The impact

- ↑ Improved forecast accuracy by 10 percentage points
- ↑ Improved planner productivity by 15-25%
- ↑ Increased automation of tasks by 30%

$20bn+ CPG company

The pain

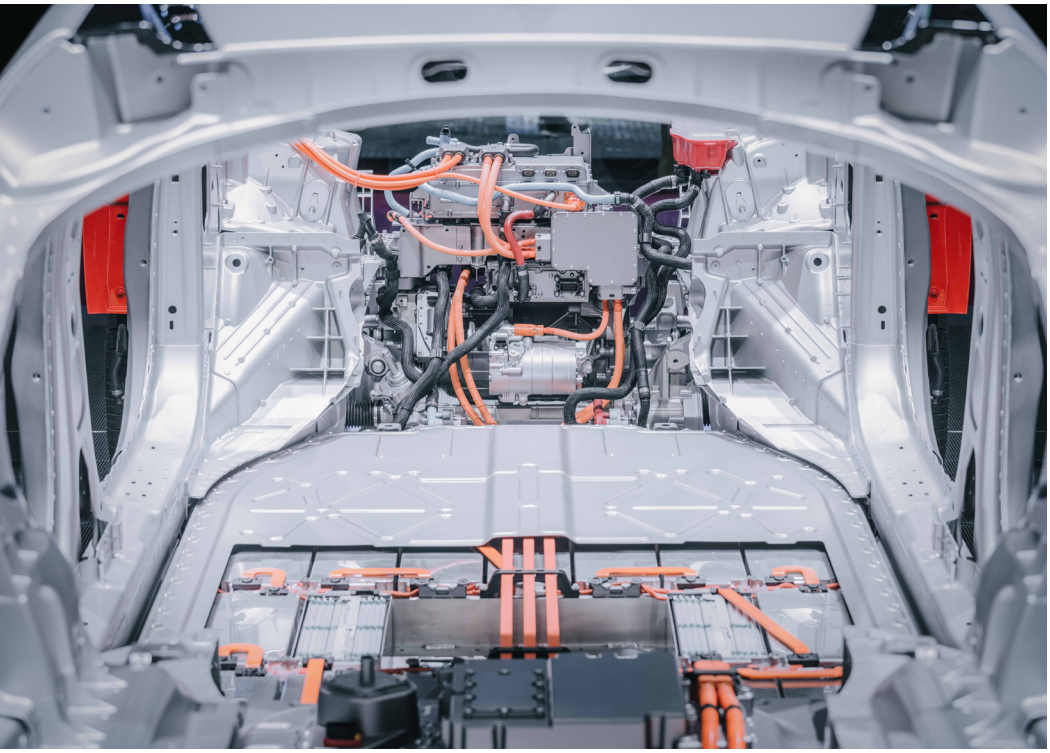
- Low forecast accuracy based on lagging indicators of demand with "black box" forecast engine
- Excessive manual number crunching in Excel
- Different functions (finance, marketing, etc.)
- Had different forecasts based on different assumptions

The solution

- Build knowledge models for both the market (competitors, retailers etc.) and demand
- Incorporate leading indicators of demand into knowledge models (sell-out data, Nielsen data, etc.)
- Leverage R and Python models to generate optimal forecast by product groupings

The impact

- ↑ Improved forecast accuracy by 5-8 percentage points
- ↑ Improved explainability of machine learning forecast
- ↑ Increased automation of forecasting process



these different capacity effectivity dates rather than requiring manual intervention and auditing.

Similarly, OEMs will have to plan around multiple new suppliers and their average/max weekly production, as well as the "sunsetting" of old supplier capacities. While it is true that OEM analysts were already managing supplier capacities for supply chain planning before, the difference lies in the **complexity inherent in onboarding so many new suppliers** and the potential disruptions that can occur. Whereas relationships existed with most ICE suppliers to the point that planners can call a supplier to ask about increasing their availability for a given week, new connections must now be formed to plan effectively and maximize each vehicle's plan. This new relationship building will be time-consuming, so efficient planning capabilities must be implemented to ensure the tech part of the equation is solid. This means automatic ingestion of supplier effectivity dates with an intuitive interface for changing these dates for when the inevitable change occurs. Moreover, the vehicle production plan must **automatically update to consider these capacities,** flagging any constraints.

The reverse logistics flow of service parts (such as batteries) will be another critical capability that must be optimized. Managing service parts is nothing new in and of itself; automotive OEMs and suppliers have worked through this for decades. While these capabilities should be optimized through advanced forecasting and inventory management, battery recycling and refurbishment management add

significant additional complexity. While the cost of batteries is expected to continue dropping, the ability to route batteries back to assembly plants to either be refurbished for reuse or recycled and sold is an added wrinkle that must now be solved. Doing so requires logistics tracking data and visibility in addition to the forecasting and inventory management capabilities mentioned earlier.

In an ideal world, the forecast for service parts and battery refurbishing/recycling would be **tethered to the finished vehicle forecast** to understand the service parts requirement driven by the current vehicle plan. Doing so requires a flexible system that can model supply for finished vehicles and their powertrain and service parts, which have distinct value chains.

Scenario planning is another essential capability to manage the shift from ICEs to EVs. It is critical to model the entire value chain and all the key players (competitors, customers, plants, suppliers, etc.) and run dynamic "what-if?" scenarios. Potential scenarios can be tactical in nature (e.g., what happens if we receive 200 batteries this week instead of 300?) or more strategic (e.g., what happens if the total industry volumes are 10% greater than anticipated?). The ideal planning platform will be able to **execute both tactical and strategic scenarios** on the same platform.

One automotive supplier o9 customer leverages the platform for both the short-term S&OP horizon and longer-term (5-7 years out) strategic planning scenarios. The result was a reduction in lost sales, supply chain costs, and inventory.

Finally, EV planning must include attributes for tracking progress towards sustainability targets. In its current state, ESG data management and monitoring progress towards corporate sustainability goals is cumbersome, manual, and requires many assumptions. To improve this, internal and external data must be leveraged **to understand the environmental footprint required** to manufacture EVs and their components, as well as the sustainability trade-off between certain decisions (e.g., if I choose supplier X with a longer lead time, what is the CO2 impact?). Scorecards must be in place to understand performance vs. targets, risks must be sensed, and the sustainability impact of strategic supply chain decisions (e.g., whether to open a new DC or not) should be known and incorporated. When sustainability KPIs are measured and optimized together with traditional operational performance indicators, companies are able to leverage AI/ML algorithms to build resilience and make better strategic decisions around both sustainability impact and risks.

Five supply chain planning planning capabilities required to manage the shift to EV's

1. Machine learning driver-based forecasting leveraging external data
2. Dynamic, time-phased supplier capacity management
3. Optimization of service parts planning (especially for batteries)
4. "What-if?" scenario analysis linking market intel to supply chain realities
5. Integration of ESG targets into core planning activities

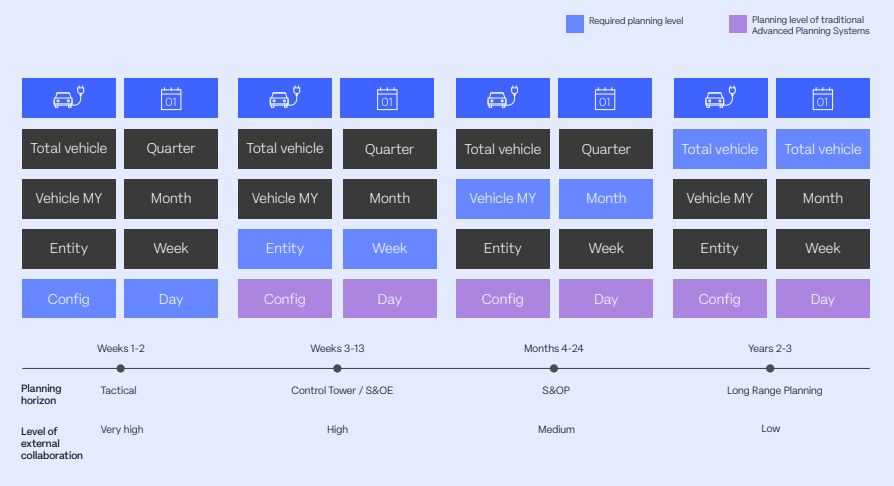
People and process: the engine behind great planning organizations

With new technology comes new ways of working. This is relevant when adopting technology that aggregates external demand signals throughout the supply chain while managing the transition from ICE to EVs. **The sheer volume of data helps generate insights** and feed analytics engines but can be overwhelming for planners to sift through**.** The proper operating model must be in place to harness these new digital capabilities and avoid "boiling the ocean." Thresholds should be set to determine what is and isn't an issue, and a decision-making cadence must be established to structure touchpoints between partners across the supply chain and ensure the right people are in the right places at the right time.

The proper operating model must be in place to harness these new digital capabilities and avoid "boiling the ocean."

One factor to consider is speed. Historically, planning solutions could be used to facilitate the monthly S&OP cycle and some weekly use cases at a high level. Modern planning technology (discussed earlier) will bring issues and insights to planners' fingertips in real-time. Thus, the standard monthly S&OP cycle **will not be the ideal planning cadence to maximize these new capabilities.** Weekly and even daily processes must be in place to flag and quickly create mitigation plans for resolvable issues (i.e., issues which don't require executive approval). Planners must have the autonomy to make decisions. This doesn't mean the S&OP cycle will go away. Instead, these supplemental weekly and daily processes **must move in concert with the monthly planning cycle** so that S&OP meetings can be used for executives to make decisions on escalation items that couldn't be solved during the weekly meetings, as opposed to merely just being used as a monthly report-out.

To effectively manage the shift to EV's, monthly S&OP planning must be on the same platform as more detailed tactical planning



Aside from an effective operating model, capabilities must be introduced to ensure that the organization's skill portfolio is as innovative as the products it produces. According to a McKinsey study[8], the shift to EVs will result in fewer jobs in some areas (e.g., fewer dealerships will be required with the change to Tesla-like e-commerce models). Still, it will **require additional software, data analytics, and digital marketing and sales capabilities.** Employees must be upskilled to leverage all the data and capabilities at their fingertips instead of being given the car keys and told: "go."

Training is the most obvious (but often overlooked) way to upskill a workforce. It is often taken for granted that one or two high-level training sessions are enough. This sort of approach leaves value on the table, as every dollar invested this year in building the capabilities of a workforce pays off **long after the initial investment.** As highlighted in a recent McKinsey whitepaper titled The capability-building imperative: Make 'purposeful investments' in people[9], "Capability building will have a direct result on your financial performance, on your ability to compete more effectively for customers, and on employee satisfaction." This means that the lens needs to go from "how can I help my planners improve their knowledge of the platform" to "how can I help my planners develop their general skillset, of which these technical capabilities are a big part."

This subtle shift can yield significant benefits. As the same McKinsey article mentions, making a concerted effort to help your employees **develop their skills pays off in many ways**. "Employees directly and tangibly saw their own performance improve... But what they noted most was their sense that they had grown in terms of personal fulfillment and enrichment... that increased their overall sense of happiness and their loyalty to the organization." It's the people who ultimately make or break a successful digital transformation. Recognizing this reality and making the necessary investments (both for internal employees and external partners) will be one big piece of what separates the winners from the also-rans.

[8] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-irresistible-momentum-behind-clean-electric-connected-mobility-four-key-trends

[9] https://www.mckinsey.com/business-functions/people-and-organizational-performance/our-insights/the-capability-building-imperative-make-purposeful-investments-in-people

Change is coming—will you be ready?

Whether the planning organizations of automotive companies are ready or not, the shift to EVs is real and growing. Deloitte forecasts that by 2030, total EV sales will exceed 30 million units, making up 32% of the entire market. While supply chain planning may not be the first thing that comes to mind when considering such a dramatic shift, effective planning can help OEMs capture market share while assisting automotive companies in reducing their costs.

Improving demand forecasting by leveraging demand drivers and machine learning models leads to the right EV being available to the right customer at the right time for OEMs. Better planning leads to lower costs and a more effective ramp-down of "sunset" components, leading to less inventory obsolescence. Qualitatively, a future-proof planning platform will enable automotive companies to plan with confidence and know that they'll be prepared to proactively respond to whatever comes next, rather than reflexively react like many companies during the recent chip shortage.

Change is never easy, and success is never assured. But not starting the journey now will be "ceding the high ground" and providing competitors with a first-mover advantage. Those who act quickly with an agile mindset (while applying the necessary precautions and due diligence) will be the victors. At the same time, those who default to how things have always been done will find themselves in perpetual catch-up mode as the world continues to change around them.