Accelerating Electrified Vehicle Production Through Risk-Mitigating Partnerships

A guide for meeting the manufacturing demands of power & charging technology

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JABIL

Purpose of this Paper

This paper will provide a brief overview of the challenges and risks associated with the manufacture of new power and charging products enabling electrified vehicles.

At this unique inflection point for the mass adoption of electrified vehicles, the challenges are substantial, but they are certainly not insurmountable. In fact, the opportunity will be significant for those who manage risk and respond with agility to this market.

A trusted, expert partner can make you more successful in accelerating time-to-market of automotive-grade power and charging technology. Especially when it comes to optimizing products for manufacturing, executing a new product launch, managing supply chain risks, developing suppliers or scaling production globally.

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Introduction
Electrified Vehicles Market Landscape and Challenges

While it is common knowledge that the electrification of automakers' fleets is on its way, the pace of adoption may surprise some. Compared to approximately 3% of today's market, IHS estimates that 50% of all cars sold by 2026 will have electrified drivetrains (MHEV, HEV, PHEV or BEV). This rises to 60% by 2029 – a true sea change within a 10-year time span.

The array of market forces driving the adoption of increasingly electrified vehicles – government regulation, technological developments, improvements in battery cost and performance, consumer demand, and more – has brought the industry to a tipping point. Electrified vehicles' shift from niche market to mainstream mobility is visibly in-process, particularly with substantial increases in EV range and battery charging speeds.

A reliable, scalable, cost-effective charging infrastructure is also necessary for the future success of the EV market. The United States faces a pressing challenge regarding this issue. The International Council on Clean Transportation reports that of 100 U.S. locations featuring charging infrastructure, 88 had less than half of the total needed in place, based on their expected EV growth rate.

The ability to reach the predicted 60% of all new cars having electrified drive trains by 2029 centers on meeting the challenge of bringing those vehicles to market at an economically acceptable price. Automakers, charging system OEMs and their supply chains must create a manufacturing ecosystem that will enable accelerated time to mass-market of electrified vehicles, while managing the risks associated with the following issues:

1. Product Design & Development
2. Investments & Asset Management
3. Supply Chain & Unforeseen Events
4. Specialized Manufacturing & Localized Footprint
5. Fluctuations in Demand

1. Product Design & Development

The automotive and transportation industries have spent the last 100+ years developing vehicles predominantly propelled by Internal Combustion Engines (ICE). But with hundreds of HEV, PHEV and EV models predicted to launch globally within the next five years, there is a substantial need across the industry to add the knowledge required to design and develop power and charging technology.

Historically OEMs have relied heavily (but not entirely) on third parties to develop and deliver off-the-shelf solutions, rather than taking an end-to-end approach for product development and production. Hence their need to invest heavily in talent acquisition was limited primarily to vehicle assembly. For those OEMs approaching their EV production in the same manner as their ICE vehicles, however, it will be vital to invest in talent with depth and breadth of knowledge regarding EV-specific technologies.

One important consideration is to identify core vs. non-core skill sets. For example, recruiting talent that supports and enables each company's differentiated value proposition and retain IP, while drawing on non-core talent needs from partners, suppliers and consultants.

Moving Away From Traditional Models

There's a choice to be made. Do OEMs follow the traditional model and purchase parts or systems from specialist suppliers? Or do they invest in their own talent and expertise to retain control over design and IP while outsourcing manufacturing?

In the case of electrified vehicles, some OEMs are following traditional models. But others are looking to retain ownership of their powertrain system design to create and maintain their competitive advantage, and then outsource manufacturing to specialists. This same choice is being faced by larger suppliers needing to develop and produce the extensive range of new technology demanded by their customers.

Automakers have more options for developing and producing technology than in the past, based on their financial, procurement, design/engineering capabilities, and IP ownership goals. Newer models are emerging, models that enable OEMs and Tier 1s to outsource design and manufacturing while retaining control of the product. OEMs and Tier 1s are thereby spared the investments and time needed to search for, and on-board, specialized talent.

Creating a Partner Ecosystem

By contracting with a manufacturing services partner, OEM and Tier 1 product and development teams can optimize the design for supply chain risk/performance, testability and manufacturability. The manufacturing solutions provider possesses the skills to take the concept and walk it through engineering, supply chain and manufacturing – i.e., the prototype skillset to drive through to production. The resulting design will drive costs down, enable high quality levels within manufacturing, allow appropriate manufacturing testing and expedient ramp to mass production.

As an example of this approach, we could look at the development of an EV traction inverter. As the traction inverter impacts the driving experience of the vehicle, it's not surprising that an OEM wants to control its design and characteristics in conjunction with their e-motors, but does not want to invest in manufacturing capabilities for the product. This leads the OEM to design the product in-house, then outsource industrialization and manufacturing to a partner with automotive expertise and quality standards. The advantage of using a manufacturing solutions provider to assist with industrializing a product is in accessing their expertise in efficiently manufacturing high-volume automotive-grade product.

2. Investments & Asset Management

The difference between ICE and EV production processes and equipment drives the need for new types of factories – not just a retooling of existing production lines. This is inevitably an expensive exercise, costing billions of dollars. Understandably, many OEMs are questioning whether this is the right way to invest this kind of money, knowing that if they do, those funds will need to be taken from somewhere else in their company.

One clear question is what automakers should do with their traditional ICE assets while they make the transition to electric. Two common scenarios illustrate this challenge:

- **The vehicle manufacturer continues to build ICE powertrains as well as new electric powertrains in order to remain competitive.** This translates into duplicate investment for the net same total volume (i.e., doubling their factory assets while not adding substantial sales volume, as their EV business cannibalizes their ICE business).

- **As volume transitions from ICE to electric, the ICE assets become less and less utilized (i.e. less economic, while the electric side becomes more economic).** This transition renders both sides uneconomic for a period of time.

This begs the question of where long-term investments should be made and what to do with aging assets. In addition, there is the challenge of managing the risk associated with the electrification market share numbers not coming through as predicted. There are two strategies that serve as a good starting point to overcome these challenges:

- **Share investment and sales channels with a partner - even a competitor.** One example is Ford's use of Volkswagen's EV platform while VW uses Ford's pickup and commercial platform.

- **Buy/outsource strategies where partners take the capex and investment responsibilities for establishing manufacturing lines and even geographic footprint.** These strategies also enable the OEMs and Tier 1s to direct their investment towards in-strategy initiatives to grow their business - for example, Eaton's partnership with Jabil.

3. Supply Chain & Unforeseen Events

For OEMs and Tier 1s accustomed to deploying supply chain management strategies based on decades of ICE-centered production, it is particularly challenging to determine how best to predict and plan for the electrification market.

The traditional ICE value chain is changing along with the new technology needed for electrification. New commodities (such as high voltage interconnects like busbars, cables and connectors) are becoming more important. So, from a supply chain point of view, OEMs and Tier 1s need to make sure that their suppliers and manufacturing partners' suppliers have the right sourcing strategy and capacity to meet flexible production requirements. Specifically:

- **Design for Supply Chain**
  Understanding the impact of different product decisions and avoiding high-risk components through early assessments during product design and prototyping stage

- **Supply Chain Visibility**
  Real-time insight on orders, compliance, problem resolution and financial performance

- **Event Risk**
  Instant alerts, impact analyses and detailed recovery options during unforeseen events – allowing a quicker recovery and minimized loss (e.g., the COVID-19 pandemic)

- **Risk Management**
  Dynamic and customized risk scoring that weighs availability, complexity, delivery and other critical supply chain risk factors to reduce vulnerability and ensure continuity

- **Supply Chain Diagnostics**
  Actionable insights across the demand and supply network to improve sourcing and partner collaboration while delivering root cause analysis of missed KPIs and key metrics

The need for a robust list of qualified suppliers is further exemplified by the unique supply chain solutions required for custom parts for power and charging technology. Consider, for example, sourcing requirements for EV charging stations. Specialist suppliers are required that have equipment, processes and know-how to accommodate large form factor, highly aesthetic plastic housings. As well as suppliers that provide mechanical housings that meet the demands of sealing, installation, maintenance and repair.

Given the increasingly specialist sourcing needs for power and charging technology, partnering with a specialist in these areas can help overcome sourcing challenges, particularly when it comes to proactively identifying qualified suppliers and developing multi-sourcing strategies that protect supply and offer component security.

Mitigating risk with a multi-source, globally distributed supply chain only goes so far. The next step is to ensure systems are in place that provide immediate knowledge in the event of supply chain disruption (e.g., natural disaster, weather impacts, factory shutdowns, etc.). The goal is to access a system that provides visibility into what's on order, where the part is being manufactured and how to find alternative sources. Recently, the COVID-19 pandemic has shown us how valuable that information can be.

In addition to risk mitigation, an advantage of a multi-sourced, localized supply chain is its ability to lower costs. Suppliers located close to the point of production reduce logistics costs, and multiple suppliers offer several solutions, thereby providing more opportunities for cost savings. Specific to the electrification field, the transition of material usage has implications for supply availability, continuity and exposure to commodity prices. For example, because copper is heavily used in power and charging electronics, multiple localized copper suppliers are key to production efficiency and lower costs.

When it comes to risk management within the electrification supply chain, uncertainties remain about: consumer demand and market development; (e.g., legislation and emissions requirements); which battery technology will emerge as the winner; and, as the COVID-19 pandemic has demonstrated, a real need to allow for the unknown.

Massive events – such as hurricanes, tsunamis, pandemic-driven recession/stimulus/recession cycles and supply chain impact, raw material shortages due to conflicts in "unstable" regions, and trade wars – have provided clear examples of why having multi-source suppliers across diverse regions is key to success in manufacturing. Although all of these events have been significant, none has had as much impact as the COVID-19 pandemic in recent years, as seen in responses to the Jabil's Supply Chain Resilience survey.

Note: for a thorough look at the big-picture market forces increasing global supply chain risk across a range of industries, please see Global Supply Chain Management: 8 Market Forces Creating Complexity.

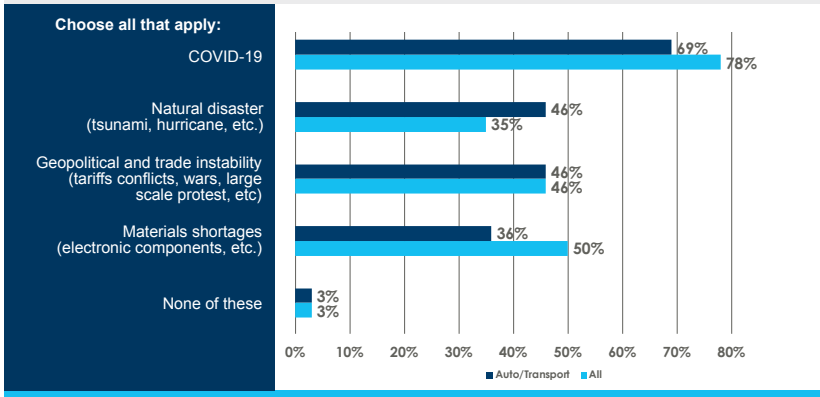
Supply Chain Resilience in a Post-Pandemic World

Jabil conducted research in August 2020 with the primary goal of capturing hard data on trends in supply chain, particularly the impact of COVID-19 and risk management. Independent sources of OEM manufacturing professionals with responsibilities for their company's supply chain were invited to participate in an online survey. A total of 715 qualified individuals completed the survey, including 105 that had responsibility for automotive or transportation. All had decision-making responsibility for supply chain budgets at an OEM manufacturing company with more than $500M in annual revenue.

The survey showed that the COVID-19 pandemic has changed how OEMs think about manufacturing partnerships, with automotive and transportation (A&T) OEMs more likely to partner than their non-A&T counterparts.

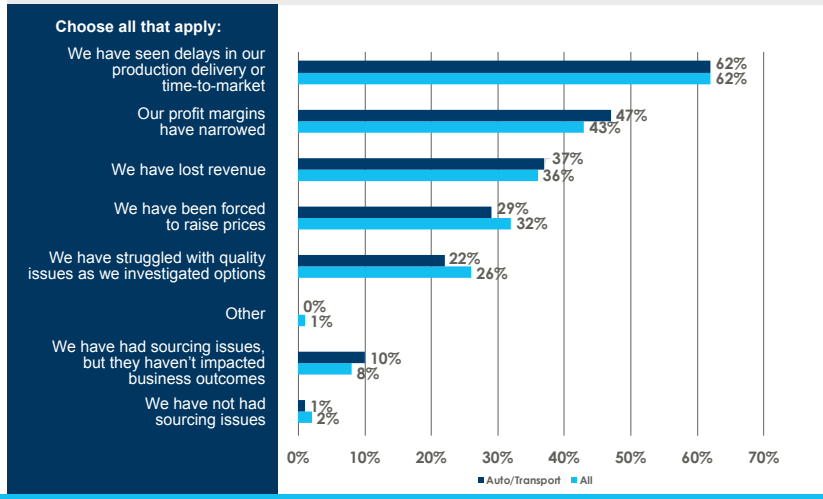
COVID-19 Impacted More Supply Chains Than Other Past Disruptive Events

Which of the following have had an impact on your company's supply chain in the past 10 years?



Sourcing Issues Have Direct Business Impact

How have component shortages, limited materials, or sourcing issues impacted your business in the past year?



4. Specialized Manufacturing & Localized Footprint

An electrified powertrain, particularly high-voltage electrification systems, requires highly complex technology with many electrical components. This is a complete change from the traditionally mechanical internal combustion powertrain.

Automated Manufacturing

With power and charging technology, the importance of automated assembly resides in its multi-board, multi-cable, complex mechanical assembly into an environmentally sealed end product. Maximized efficiency, quality of the finished product and repeatability during production of safety-critical technology can be achieved through highly automated manufacturing. However, some of the challenges that automation has to accommodate are:

- **High-voltage product**
  Safety aspects in manufacturing and testing and in the vehicle usage itself
- **Thermal dissipation**
  Complicated assembly processes of products requiring high thermal dissipation
- **Weight and dimensions**
  Large, heavy and non-uniform housing
- **Multiple boards and sub-assemblies**
  Fitting, attaching and interconnecting are very dexterous processes
- **Process validation and control**
  Critical in the manufacturing environment for controlling and measuring each of the inputs and ensuring a very controlled and repeatable output
- **Cost of poor quality**
  Units can be very complex – any kind of failure passed along manufacturing stations, in subsequent operations or in the finished unit can be very costly

Assembly processes – such as mounting, heat-staking, welding, fastening, bonding, potting, dispensing, etc. – can all be automated, leading to high-quality repeatability.

With the right expertise, even complex product assemblies such as battery junction boxes, on-board chargers or traction inverters can be produced using highly automated manufacturing techniques. Processes that can be fully automated to deliver the highest quality at best efficiency include: cable preparation (cutting, stripping, crimping, welding, potting, pre-forming) to material dispensing, board and sub-assembly mounting and fastening, interconnecting, seal dispensing, enclosing, fastening and testing.

Test Strategies

Testing goes together with manufacturing. Integrating the manufacturing test strategy into the manufacturing process is almost as important as the production itself. Navigating high-voltage product testing (rather than the low-voltage systems used in ICE production) requires the right equipment and expertise.

Robustness tests (such as resistance, hi-pot, leak and other types of tests) are critical in ensuring the reliable performance of safety-critical products in the field.

Specialist Manufacturing

Automotive power and charging electronics manufacturing requires a significant amount of expertise, competence, and specialized processes, equipment and facilities. Re-purposing existing factories and labor takes substantial investments in buildings, equipment and know-how. Therefore, it makes sense to partner with manufacturing specialists who have already made investments and built expertise in automotive-grade production capabilities.

Electronics manufacturing becomes even more specialized when it comes to automotive electric vehicle power and charging electronics. For example, when leveraging specific reflow, wave and soldering strategies to overcome issues that can inhibit thermal conductivity of the power components, the automated high speed and accurate dispensing of liquid adhesives, thermal pastes, fillers and sealers all require specialized equipment and knowledge. Assembly techniques (including welding, staking and screwing/bolting) are particularly challenging when it comes to the delicate nature and exacting specifications of the components and sub-assemblies.

Testing power and charging technology requires significantly different tests than standard electronics product testing, from the application of high-voltages and large loads, to the use of liquids in cooling channels.

Cleanliness Requirements

Within the automotive industry, the term “technical cleanliness” refers to minimizing contamination so that particles will not constrain or interfere with the subsequent function of the technical component. The technical cleanliness requirements adopted by the automotive industry are designed to address the failure modes associated with higher stress levels and lower tolerances of components, as well as the increasingly complex auxiliary components being installed. Cleanliness is considered a quality factor, with evidence showing a link to zero-kilometer breakdowns due to large particle (>200um) contaminants and limited life failures due to an accumulation of small particle (<10um) contaminants.

Cleanliness becomes crucial when creating sealed components subject to harsh environments, such as extreme temperatures generated during the operation of the unit. In such an environment, any type of contaminant can become dislodged and create electrical interference, short or mechanical blockage/interference. Process optimizations to avoid particle generation must be pursued on a continuous basis.

For the manufacture of power and charging technology, many OEMs and Tier 1s require ISO 16232, ISO 13485, ISO 14644, VDA 19.1 or VDA 19.2. Regardless of certification, Cleanliness Grades (CGs) are to be assessed, controlled and maintained. Study of environment particles and product is necessary to demonstrate current standards are met.

Geographic Footprint

As electric and hybrid vehicles become mainstream the application of global platforms drives economies of scale. The ability to deliver power electronics globally from local production facilities is of paramount importance as logistics concerns are significant due to the size, weight and cost of the end products. Of course, the same power electronics manufacturing competence must be present in all the local facilities.

5. Fluctuations in Demand

Government-sponsored incentives are instrumental in driving long-term increases in demand. In Europe especially, EV incentives have been ramped up in the wake of the COVID-19 pandemic. Per a report from the Institute for Energy Research in June 2020, "Both Germany and France are increasing their subsidies for electric vehicles in their COVID-19 recovery packages...Germany increased its incentives for electric cars by 50% and taxed SUVs with combustion engines as part of a €130 billion ($146 billion) stimulus package. The French government announced plans to offer generous incentives to buy an electric vehicle that provides up to €12,000 ($13,150) and is part of an €8 billion rescue plan for the country's auto industry. Over €1.3 billion will be used as incentives to reduce the price of battery-electric vehicles by up to 40% in some cases."

In China, the world's largest NEV market, IHS expects more than 320 models to be competing in the BEV segment by 2025, up from 237 in 2020. These new launches will help EVs to gain a wider consumer base and attract new investments in the sector to improve infrastructure for EVs.

In response to current government regulations, incentives and consumer demand, automakers are planning on launching hundreds of HEVs/BEVs over the next five years. Despite these launch plans, there is no crystal ball as to which models and powertrains will be the ultimate winners. It can be expected that there will be some volatility in the HEV/BEV volumes as local, national and regional regulations change and incentives come and go, which makes production flexibility a key element to automaker supply chain and manufacturing strategies. This is especially important when you consider the level of investment required to bring new electrified vehicles to market. Capacity needs to be adjusted quickly with direct suppliers, their suppliers/supply chain, as well as labor.

This once again leads us to the value of outsourcing manufacturing of core technology by partnering with the right suppliers who can move flexibly (in either direction) in response to automakers or market demand.

Summary

Among OEMs and Tier 1s, current trends point to electrification continuing to represent the forward-looking movement in the automotive industry. All of the moves that need to take place to make electrification successful are happening, albeit at a cautious and somewhat uneven pace around the world. Most of the automotive market players are shifting their strategy and betting heavily that electrification is going to be to their competitive advantage; however, the path forward is peppered with challenges.

As noted earlier, there are several non-traditional and new models for designing, developing and producing solutions for vehicle electrification. One way vehicle manufacturers can navigate finding the right business and partnership structure for their needs is to leverage manufacturing solutions providers.

This concept is about opening up and reaching out to collaborators whose capabilities and experience will truly help unleash the power of agility into the manufacturer's product management strategy. Enlisting outside expertise is one of the most effective ways to manage risk:

- **Product Design & Development**
  The right manufacturing partner has the expertise to know whether a part or systems design is ideal for efficient and cost-effective mass production. If it is not, it can be re-designed for manufacture in the development cycle, resulting in better throughput and higher repeatability and quality. Better yet, earlier engagement in product development ensures a partner's expertise and experience can be leveraged at the start of the product lifecycle.

- **Investments & Asset Management**
  The creation of resident expertise in the manufacturing of components and systems for electrified powertrains is critical to support this growing market at the right quality levels. The investment and time required to reach this point – both in assets and experience – can be prohibitive. Through outsourcing to specialist manufacturing partners, the investment and risk is absorbed by the partner, with the added benefit that the customer can direct its investments toward its strategic business objectives.

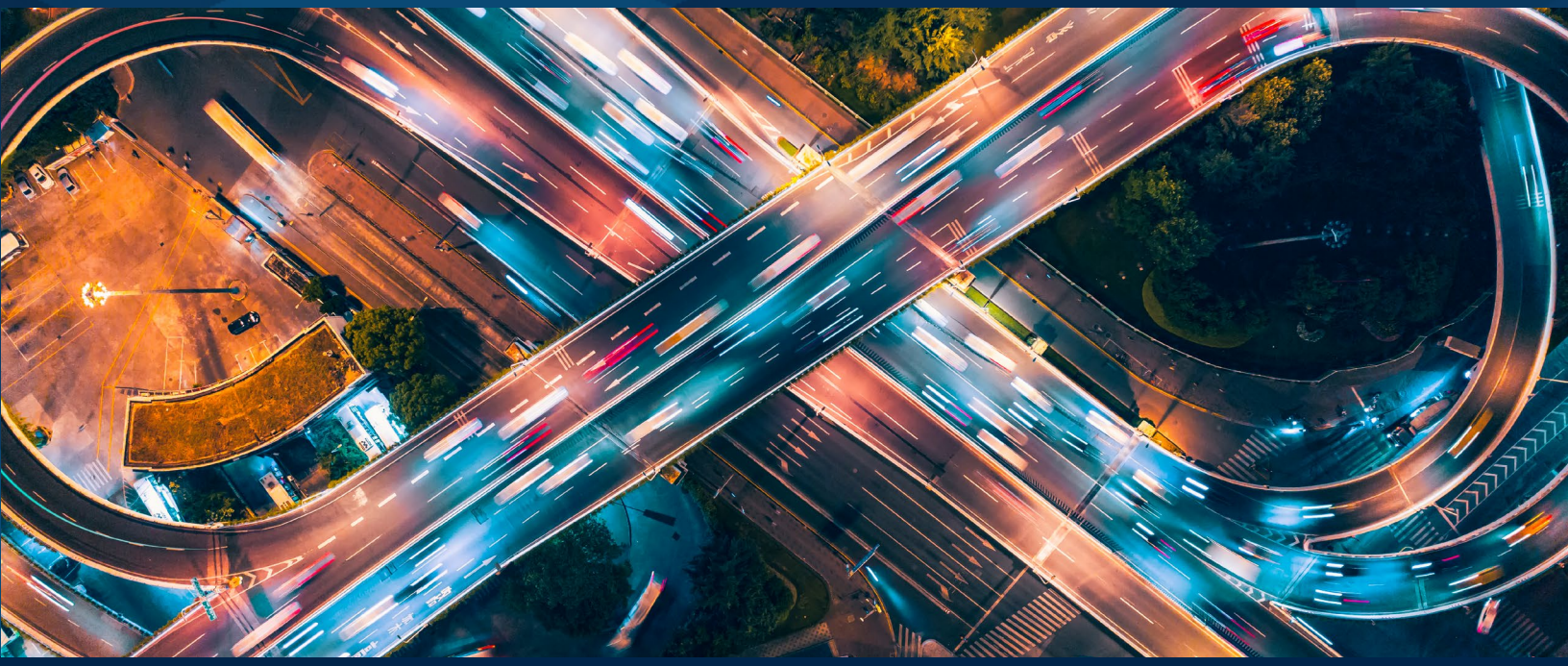
- **Supply Chain & Unforeseen Events**
  A manufacturing partner will be able to identify multiple reasons why a part may not be ideal, from life cycle (advance knowledge that it will be out of production soon) to lack of geo-redundancy, which means the part is only made at one plant, to shipping challenges associated with heavy parts. Working with a partner that has deep knowledge of the life cycle of the components needed for automotive electrification can help manage supply chain disruptions. A good example is EVBox, which has the goal to build future-proof EV charging solutions for every electric car, parking space and power capacity. To prioritize growth, EVBox outsourced its supply chain management to a specialist partner with a global footprint, freeing itself to focus on its core competencies and operations.

- **Specialist Manufacturing**
  For automotive electronic manufacturing service (EMS) partners, their business foundation has traditionally been in populating the printed circuit board assembly. However, over the last decade, several EMS companies have been adding more and more value to the backend, investing in specialist capabilities, processes and expertise to provide greater support to their customers. We've already established that the production of high-voltage systems enabling vehicle electrification requires specialist expertise, processes and manufacturing environments, all of which a strategic manufacturing partner will continue to invest in on behalf of their customers.

- **Fluctuations in Demand**
  With the right frameworks in place, a manufacturing partner can support its customers with fluctuations in demand, meaning that they can support volume or geographic growth, as well as sudden changes in demand, most recently seen with the global COVID-19 pandemic.

A good partner will ultimately help mitigate the risk associated with bringing a manufacturer's power and charging technology to the mass market.

To learn more, visit: Jabil.com



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