Driving supply chain agility with *order simulation*

How advanced technologies such as GenAI help overcome the challenge of predicting future market demand in an automotive business that builds complex products to order

A Capgemini point of view

Executive summary

To fully meet market needs, OEMs must offer build-to-order vehicles alongside build-to-stock. Doing so has presented major challenges in terms of predicting the parts required, with knock-on effects throughout the business and its supply chain. Many of these challenges arise from the huge number of variants that are needed when customers personalize their cars by selecting their preferred combination of options. The challenges are aggravated by the fact that OEMs need to start forecasting parts requirements before the market has even seen the product. Now, however, these challenges can be overcome with the aid of innovative approaches harnessing advanced technologies such as AI. Seizing this opportunity will confer an important competitive advantage.

Introduction: Build-to-Order is a key strategy in automotive

To establish a global presence and cater to diverse market segments, OEMs know they must adopt a combination of build-to-stock and build-to-order strategies. This observation is particularly relevant to the electric vehicle (EV) segment, which, having been a seller's market initially, is now in the process of becoming a buyer's market, with many different players competing for business.

Build-to-Stock vs Build-to-Order

Build-to-Stock	Build-to-Order
Products are manufactured and stocked before customer orders are received.	Products are produced only after the customer order is received.
Primary goal is to optimize production and take advantage of economies of scale.	Primary goal is to customize products to meet individual customer specifications.
Common in industries with relatively stable and predictable demand patterns, such as economy cars.	Common in industries where customization and personalization are important, such as premium veichles.
Manufacturers may have limited pricing power and may struggle to command higher prices.	The ability to customize, personalize, and differentiate products justifies the higher price point in the eyes of customers, who value the unique benefits and features offered by these products.

Build-to-stock cannot comprehensively meet the demands of a buyer's market, because one of the main ways sellers compete to win buyers is by offering individualization. To encompass all market segments, OEMs must therefore pivot toward a build-to-order strategy, To encompass all market segments, OEMs must therefore pivot toward a build-to-order strategy, while still building to stock where appropriate.

For example, the U.S. is predominantly a build-to-stock market, where customers buy cars "as seen" at a dealership. In Europe, on the other hand, build-to-order has a high market share. OEMs need to be able to deal with diverse markets in which the ratio of build-to-stock to build-to-order varies considerably.

From working with major OEMs, we know that the build-to-order trend poses substantial challenges for traditional forecasting approaches. As we'll explain below, these approaches struggle to cope with the build-to-order situation, where there can be enormous numbers of part variants and a constantly changing picture of what is needed and where.

To make build-to-order strategies viable and profitable, these challenges urgently need to be overcome. Fortunately, it's now possible to do so thanks to some innovative analytic techniques that leverage modern technologies.

This report describes and illustrates the challenges of predicting parts requirements for build-to-order and their potential impact, and discusses the limitations of traditional approaches – a complication affecting every OEM who is making the transition from a sellers' market to a buyers' market and needs to offer configurable vehicles. It then explains how technological innovation can help, and outlines the business benefits of this new approach.

Build-to-order poses special challenges when forecasting parts needs

When building to order, the ability to forecast parts requirements depends on predicting demand for the various customization options – and combinations of options – in an accurate and timely way. The forecasts then need to be progressively updated to reflect extra information that comes along later.

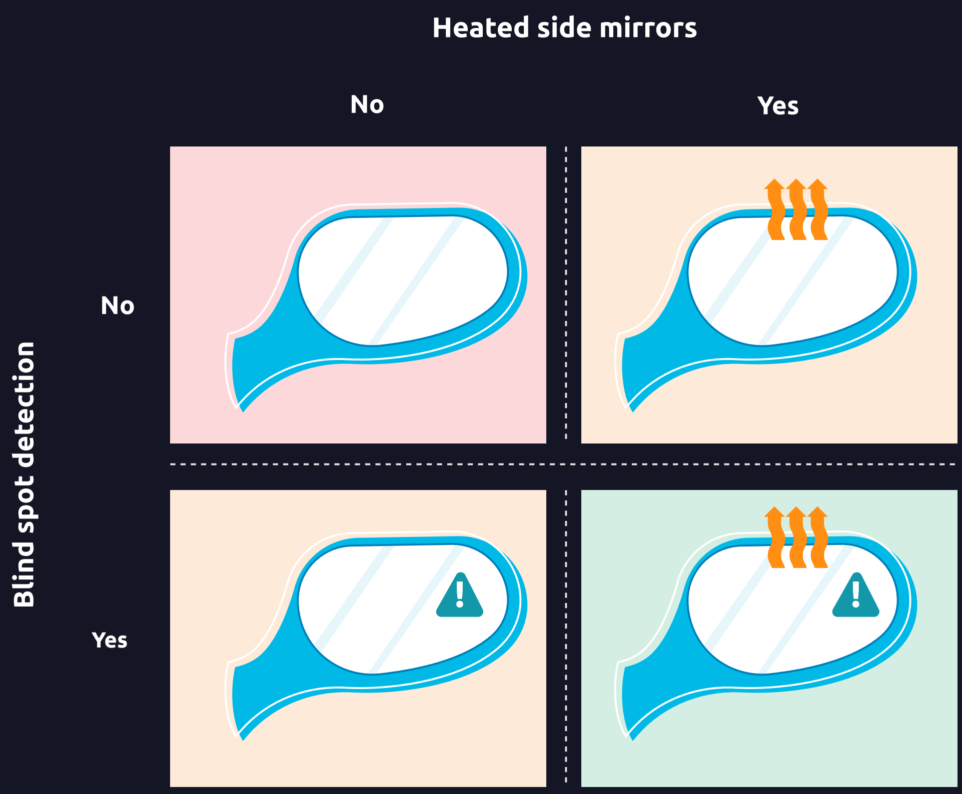
To see why this is so difficult, let's think first about the number of part variants that we're typically dealing with. A modern car is assembled from around 30k physical parts if we count everything down to the last nut and bolt. However, the same model's bill of materials is likely to contain more than 50k parts. One reason is that many parts have multiple variants – for example, there might be a choice of several radios.

In addition, though, the different ways customers can combine options may generate additional possibilities – exponentially increasing the number of part variants. Please see the next page for an example.

Why build-to-order rapidly increases the number of part variants

For example, let's consider side-view mirrors. An OEM might offer a standard mirror, plus two options: blind spot detection and heating for winter. This may sound simple, but assuming the customer can choose any combination of the two options – neither, one or the other, or both – we now have four different variants for one mirror. And that's before we even consider color, which will complicate things further.

Simplified example: side mirror with two options -> 4 variants



The mirrors are likely to be made by external suppliers. Two years before production starts, the OEM needs to communicate to these suppliers how many of each side-view mirror variant will be required, so that the supplier can prepare its plants and production lines to produce the right volumes of each.

Even if the OEM is confident that 25% of customers will want the heated mirror option and 70% will want the blind spot alert option, it's not easy to work out how many of each variant will be chosen. So knowing how many of each item to request is far from straightforward in a build-to-order situation.

In addition to the large number of part variants and the complexity they add, another difficulty is that the overall picture is often highly volatile. The whole point of build-to-order is to win business in highly competitive markets. OEMs are constantly introducing new options and new incentives to ensure that they do just that. Car models are updated annually to meet the latest market needs – so, for example, a new color may be introduced or the list price may change, both of which affect demand. And, given that supplier contracts are signed two years ahead of production, there is plenty of time for planning assumptions to change.

Too often, the net result is the OEM's eventual call-offs are quite different from the forecasts given to suppliers months or years earlier.

Inadequate forecasting of parts needs has serious implications

Mismatches between forecasts of parts needed and actual call-offs can cause all kinds of issues for OEMs, their suppliers, and their customers.

OEMs may run out of the parts they need and have to move parts or orders to different regions, and/or reschedule orders to later periods – all of which has knock-on effects for those regions and periods. And, of course, postponing the assembly of some orders also causes problems with subsequent forecasts, creating a vicious cycle.

These issues have a variety of undesirable effects such as:

- Orders lost because of unacceptable delays in delivering finished custom vehicles
- Lack of trust between client and supplier, right along the supply chain
- Resources wasted and working capital tied up because of a "just-in-case" approach to inventory.

In short, mismatches between predictions and needs for different part variants can have a disastrous effect on both OEMs and suppliers, as well as undermining relationships between them.

So, especially when a product has many part variants, accurate forecasting is essential. That forecasting must be accompanied by early identification of critical options (see next page).

Why identification of critical options is essential

There's another issue that forecasting needs to address when building to order. The OEM needs to be able to identify which options are critical, i.e. which of them affect the demand for multiple parts.

Identifying the critical options involves distinguishing between:

- "Good" options, such as car rims, which, despite expanding the variant spectrum, do not noticeably affect the overall part demand. This is because each rim option corresponds to a single part number, without influencing any other components of the vehicle.
- "Bad" options that influence one other part. For instance, an optional folding table in the back seat affects the design of the passenger seat and consequently doubles the total number of seat types that need to be available. Two vehicles that are identically equipped – aside from the optional folding table – will have different passenger seats, and the OEM must call off the right version of the seat.
- "Ugly" options that influence not just one but many other parts. For example, an optional 360° view provided by a camera integrated into the side-view mirror doubles the number of variants of that mirror, but also of the wiring harness.

By categorizing options in this way, the OEM can ensure that the number of part variants remains less than the available historical data – a requirement for the use of advanced techniques such as machine learning (ML) to predict demand. Knowing what is critical also makes it possible to avoid offering options that will jeopardize production schedules.

Legacy approaches fail when confronted with build-to-order complexities

For purchasing purposes, parts requirements need to be predicted over the whole product lifecycle of five to six years. Historically, the industry has tended to rely on two distinct forecasting approaches:

1) Scenarios based on market research and assumptions ("qualitative approaches")

Early in the lifecycle, demand predictions are needed two to three years ahead of production to facilitate the purchasing function's estimates of part quantities, which in turn are needed to initiate supplier sourcing processes.

However, at this stage there is no historical data on which to base predictions. Therefore, a scenario-based approach, relying on market research and assumptions, is used.

The scenarios are used to create a small set of representative orders, which are then scaled up as a basis for estimating parts requirements.

2) Forecasts based on historical data ("quantitative approaches")

Following ramp-up and several months into production, sufficient historical data will have been collected to be used as a basis for forecasting.

Basic techniques such as analyses of time series via spreadsheets or within ERP systems have generally been applied to this data. The techniques have tended to be applied at the level of individual parts, whereas what we need for build-to-order is forecasts for each of the part variants (i.e. specific parts satisfying different combinations of customer options).

Advanced predictive methods such as cluster analysis, machine learning, and perhaps generative AI, can also be applied to the data, but our observation is that most OEMs are in the early stages of doing this, or haven't started yet. Most traditional players have decades-old legacy applications that are incompatible with modern ML methods.

As we've seen, these two approaches tend to be applied at different stages of the vehicle lifecycle, so to that extent they complement each other.

However, the way OEMs use these approaches doesn't currently provide a sufficiently joined-up approach to meet lifecycle needs. As well as technical limitations, this may reflect the fact that the methods have tended to be applied independently of one another. Broadly, ERP and time series analysis is used by production and logistics to forecast what is needed from suppliers in the relatively near future, while scenario planning is usually used by marketing and product management to anticipate the more distant future.

So the approaches are associated with separate systems, people, and types of results, and can't easily be combined to give an accurate and up-to-date picture of parts demand throughout the lifecycle.

An additional limitation of traditional qualitative approaches, in the context of build-to-order, relates to the use of representative orders. It is difficult to identify which orders are truly representative when there are millions of potential part variants. In addition, these approaches can't identify ugly options. So there's a high risk that the selection doesn't include the outliers that would hurt production schedules the most.

OEMs can now achieve accurate, timely, and dynamic forecasts

How can OEMs make accurate forecasts throughout the complete lifecycle of build-to-order models, as well as for build-to-stock?

What is needed is an easy-to-use, end-to-end solution to address the entire lifecycle, with qualitative and quantitative elements fully integrated to produce forecasts that are as accurate as possible at each stage of the lifecycle. The solution must address the needs of the entire organization, not just one function. Finally, it must make full use of the latest technology to offer advanced functionality in a user-friendly and seamless manner.

Let's look at those characteristics in more detail.

1) A solution for every stage of the lifecycle

Wherever suitable historical data is available, the solution should apply statistical functions and machine learning techniques to that data to generate predictions. Otherwise, it should use scenario planning based on the most reasonable assumptions.

In practice, qualitative and quantitative approaches will often be combined. For example, if an additional color is introduced, it should be possible to use existing data, plus assumptions about how popular the new color will be in specific markets, to predict how many of each variant will be required.

The forecasting process should be progressive and iterative. It should be straightforward to rerun the analysis and refine the forecast as more data accumulates, or as it becomes clear that plans will change. For example, if the OEM plans to move units between markets, or offer incentives in a given market for a particular set of options, the forecast should be readily updated to reflect that.

With these capabilities, OEMs can produce robust forecasts that take account of data already collected about the past, and add in knowledge about the future.

2) A solution for the whole enterprise to use

The solution should meet the needs of all functions in the organization, with everyone basing their decisions on the same set of accurate and up-to-date forecasts. This shared perspective for the whole organization will help break down internal silos (e.g. production versus marketing). It should also enable transparent and reliable communication with suppliers.

The key to a shared perspective is to have the tool work from a single enterprise-wide database, within an order-based setup. With an order-based approach, the order is used as a kind of lingua franca for communication between individual systems. An order can fully represent every customer demand, and any information required can be derived from simulated orders.

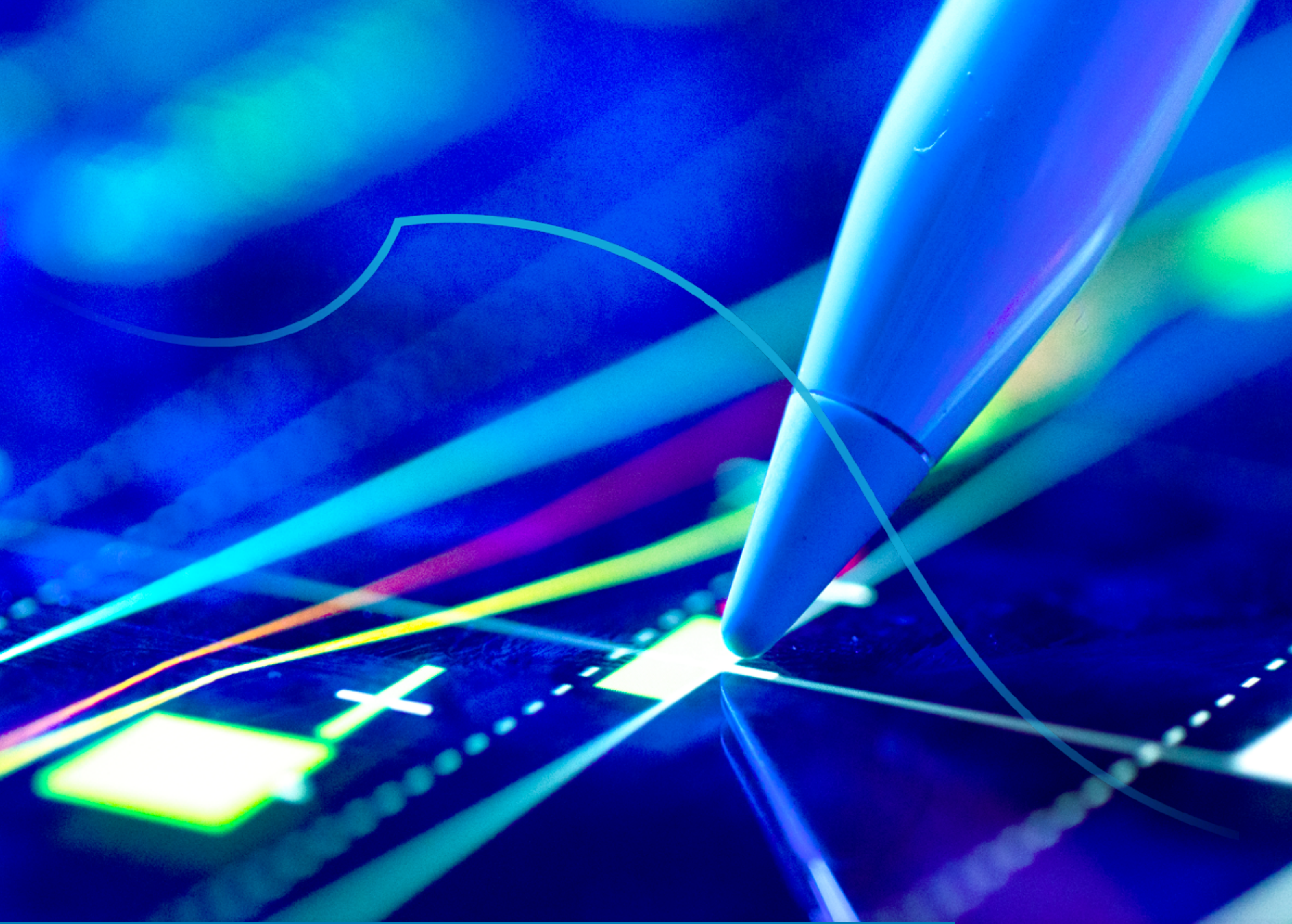
It should also be easy to feed forecasts from the solution into a wide range of processes for more accurate planning, e.g. to simulate future revenue for financial purposes, or to model build cycles in production. This should lead to better-informed planning, company-wide and in the supply chain.

3) Use of new technology to provide advanced functionality

Capabilities to look for in the solution include:

- An advanced UI that seamlessly combines multiple analytic techniques, making them accessible to managers and other decision-makers, as well as professional analysts.
- The ability to identify which options are critical by categorizing them as good, bad, or ugly, as described earlier. For this analysis, it's essential that the tool can deal with an unlimited number of part variants.
- Algorithms to adjust for unrepresentative performance (and hence data) during ramp-up (where vehicles such as show cars and press cars are not representative of those subsequently sold) and ramp-down (where incentives are offered to use up parts that will soon be obsolete).
- A facility for simulating changes that are not yet production-relevant without the need for a parallel environment.

As a general point, the solution should generally run in the cloud to enable rapid and cost-effective scaling up and down of resources according to the amount of planning activity required and the timescale within which it must be completed.



"Order Simulation for Automotive is an excellent example of an industry-specific solution built on the SAP® Business Technology Platform Platform. It shows how the industry cloud approach gives customers access to innovative solutions tailored to the needs of their industry – solutions offered by partners such as Capgemini, but also by SAP itself. Where there are difficulties in reliably forecasting demand for vehicle option configurations, this sophisticated and user-friendly simulation tool should be considered."

Hagen Heubach

Global Vice President Industry, Automotive Business Unit, SAP

This new approach delivers benefits across the business and beyond

Benefits of this approach include:

Closing the gap between forecasts and actuals: You effectively gain a digital twin of the future car, which narrows the gap between plans and real orders, and helps you close it further as you gain more information.

Proactive optimization in the factory: The forecasts make it possible to optimize shop floor performance, belt cycle, and setup time, better determine production strategy, and so on.

More sustainable use of resources: Accurate forecasting and planning enables better inventory management, without the need for just-in-case stocks.

Enhanced supplier trust: More reliable and timely information about future orders and call-offs rebuilds relationships right along the supply chain.

Shaping your future market: Marketing can use the good/bad/ugly categorization to ensure it promotes the options that work best for you, as well as your customers. The effects of proposed incentives to buy a particular variant can be simulated to ensure that they are positive for both OEM and supply chain.

Better use of employee time: Planning that used to take weeks can happen in hours, freeing up employee time for strategy and innovation.

A solution built on SAP Business Technology Platform

To meet the need for accurate, timely, and dynamic forecasting that works for both build-to-order and build-to-stock, Capgemini has developed Order Simulation for Automotive. This innovative SaaS solution has been built on the SAP Business Technology Platform to predict future configurations for millions of automobiles. Contact us to learn more.

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Predicting future demand for automotive parts poses significant challenges for manufacturers – particularly at a time when many vehicles are being built to order to satisfy customer demand for individualized experiences. Order Simulation for Automotive overcomes those challenges, enabling manufacturers to communicate their needs to suppliers in a timely and accurate manner. This SaaS solution built on SAP technology demonstrates the value of our data-driven approach to innovation. And it’s just one of the ways we’re empowering automotive companies to optimize their supply chain through advanced technology”

Laurence Noël,

Global Automotive Industry Leader, Capgemini

Author

Maid Jakubovic

Supply chain expert,
Automotive cloud initiative with SAP
maid.jakubovic@capgemini.com

Experts

Laurence Noël

Global Automotive industry leader
laurence.noel@capgemini.com

Anke Rieche

Global program lead,
Automotive cloud initiative with SAP
anke.rieche@capgemini.com

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