LEADING IN
PRODUCTION
EFFICIENCY

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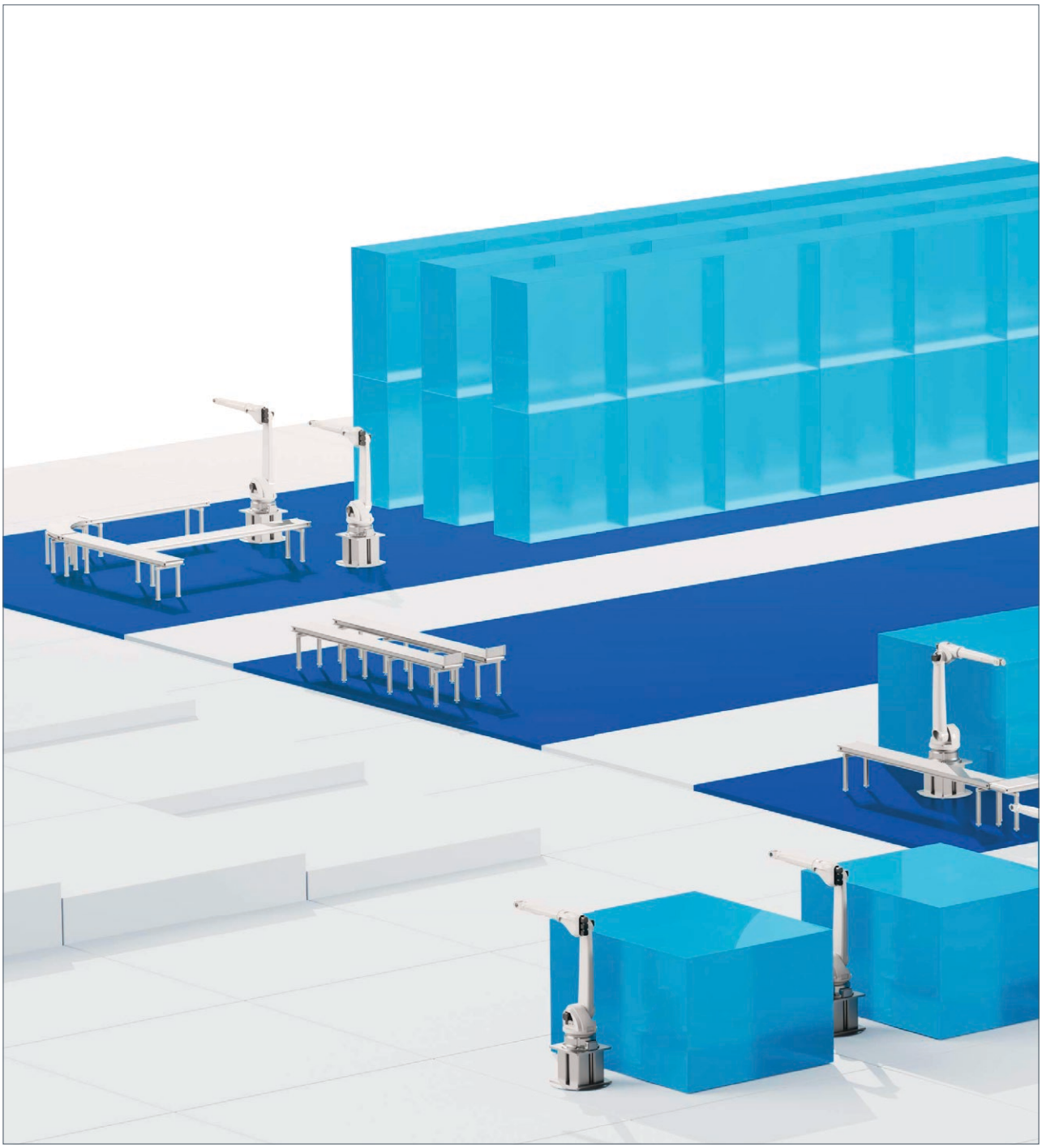

WHITE PAPER

Production-Strategy Assessment

for New Vehicle Concepts and Production Technologies

Production-Strategy Assessment

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Abstract

Automotive OEMs are continuously seeking innovative ways to enhance the efficiency of their vehicle production. Currently, radical new vehicle architectures and upcoming automation solutions are under discussion.

At DÜRR Consulting, we specialize in automotive production planning and offer profound insights into the industry's latest developments. As a part of the DÜRR Group, one of the world's leading mechanical and plant engineering companies, we possess extensive knowledge of the newest trends in plant technology. This expertise makes us the perfect partner to help you navigate the exciting challenges that lie ahead in the future of the industry.

We have developed a systematic production strategy assessment to help you evaluate the potential impacts and benefits of new developments for your global production. This is the starting point to guide you from idea to SOP and minimize the impact of any challenges you face along the way.

Introduction

In the dynamic landscape of today's automotive industry, companies are confronted with a multitude of challenges, ranging from intensified global competition and evolving consumer preferences to strict sustainability requirements. To maintain a competitive advantage, OEMs are continuously seeking innovative solutions. Recently, an increasing number of OEMs have introduced highly innovative, modular vehicle concepts, which are expected to significantly reduce crucial KPIs such as production costs and factory footprint. Meanwhile, discussions continue regarding drivetrain architectures, including internal combustion engines, battery electric vehicles, and fuel cell drives. Additionally, pioneering production methods, such as humanoid robots, are currently in development and primed for market entry.

These advancements have created a landscape of increasing complexity, presenting a challenge for automotive companies to navigate. In response, we from DÜRR Consulting have developed a standardized production strategy assessment to offer guidance and orientation for automotive companies. The whitepaper provides a comprehensive overview of the development trends and introduces the approach of the production strategy assessment.

Current trends

in automotive production

Figure 1 shows a selection of development trends in automobile production. These trends can be distinguished between those resulting from the design of the vehicles and those from newly developed production technologies.

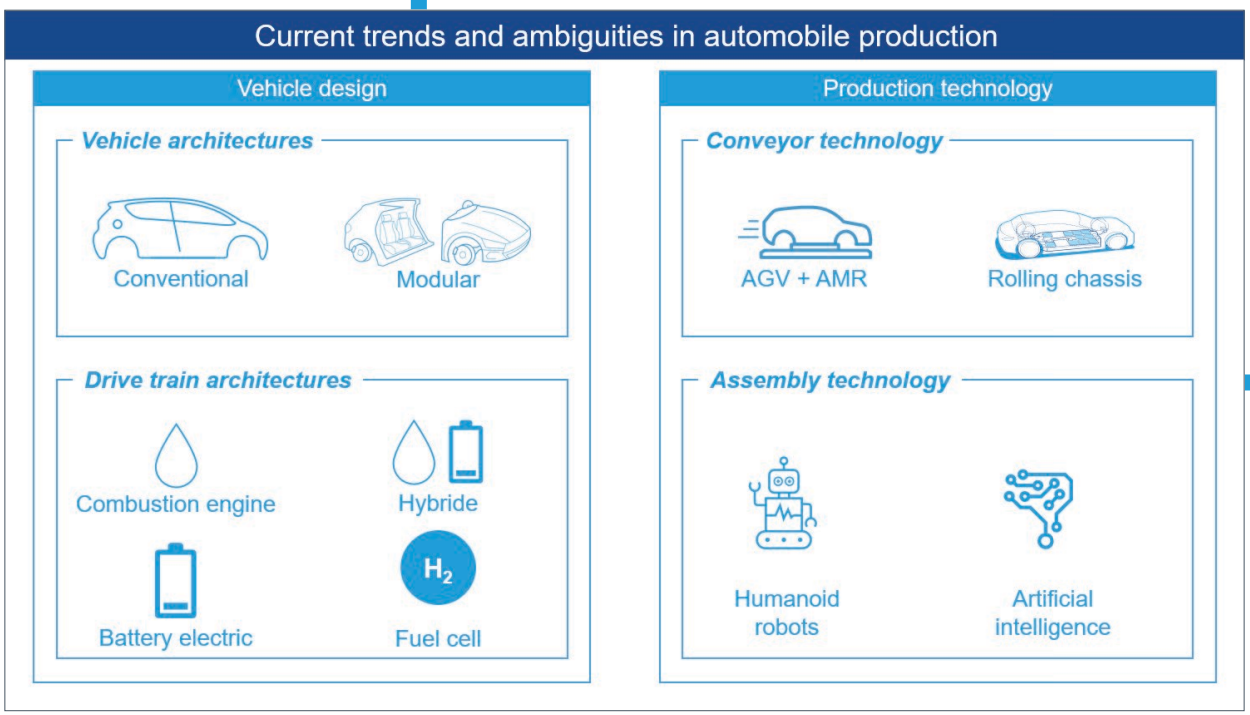

Figure 1: Current trends and ambiguities in automobile production

DÜRR Consulting: Production-Strategy Assessment: Strategic orientation for companies with a view to current development trends in automotive production.

Current trends

in automotive production

VEHICLE DESIGN

ARCHITECTURE

All established OEMs are pursuing the advancement of conventional architectures. Additionally, new architectures are emerging. For example, Toyota (Next-Generation EV) and Tesla (Unboxed) have released new modular car concepts [1, 2]. Tesla extensively addressed the "Unboxed" concept at an investor event in March 2023 [3]. According to their statements, the modular concept is expected to bring significant improvements: As depicted in Figure 2, the new vehicle architecture has the potential to reduce material costs by 50 %. This reduction is primarily achieved by employing methods such as Giga Casting, which significantly reduces the number of individual parts needed. Moreover, Tesla asserts that a 30% decrease in production time is achievable due to the higher density of workers and robots, made possible by the modular approach, which enables multiple concurrent work processes. This results in a decreased production footprint. Additionally, Tesla projects a CapEx reduction of around 30%. [3, 4]

Another trend is the "cell to body" or "cell to chassis" approach, which integrates battery cells directly into a car's structure, reducing the need for pack and module levels. This approach simplifies handling and manufacturing steps. Companies like, BMW, BYD, and Tesla are using this approach or planning to use this method [5, 6, 7].

DRIVE TRAIN ARCHITECTURES

Despite various announcements to ban the registration of new ICE vehicles (internal combustion engine) in the 2030s, there is still uncertainty regarding their future [8, 9]. Many OEMs continue to equip their production facilities for internal combustion engines (ICE) vehicle manufacturing. The future viability of hybrid models also remains unresolved.

Currently, battery electric vehicles (BEV) are predominantly available as an alternative to ICE vehicles, but fuel cell electric vehicles (FCEV) are also under development. For example, Stellantis and Toyota, and trucks such as Daimler Trucks and Nikola [10, 11, 12, 13] are exploring FCEV's for specific use cases.
For the future viability of automotive companies, OEMs must actively monitor these developments to adapt their production strategies accordingly.

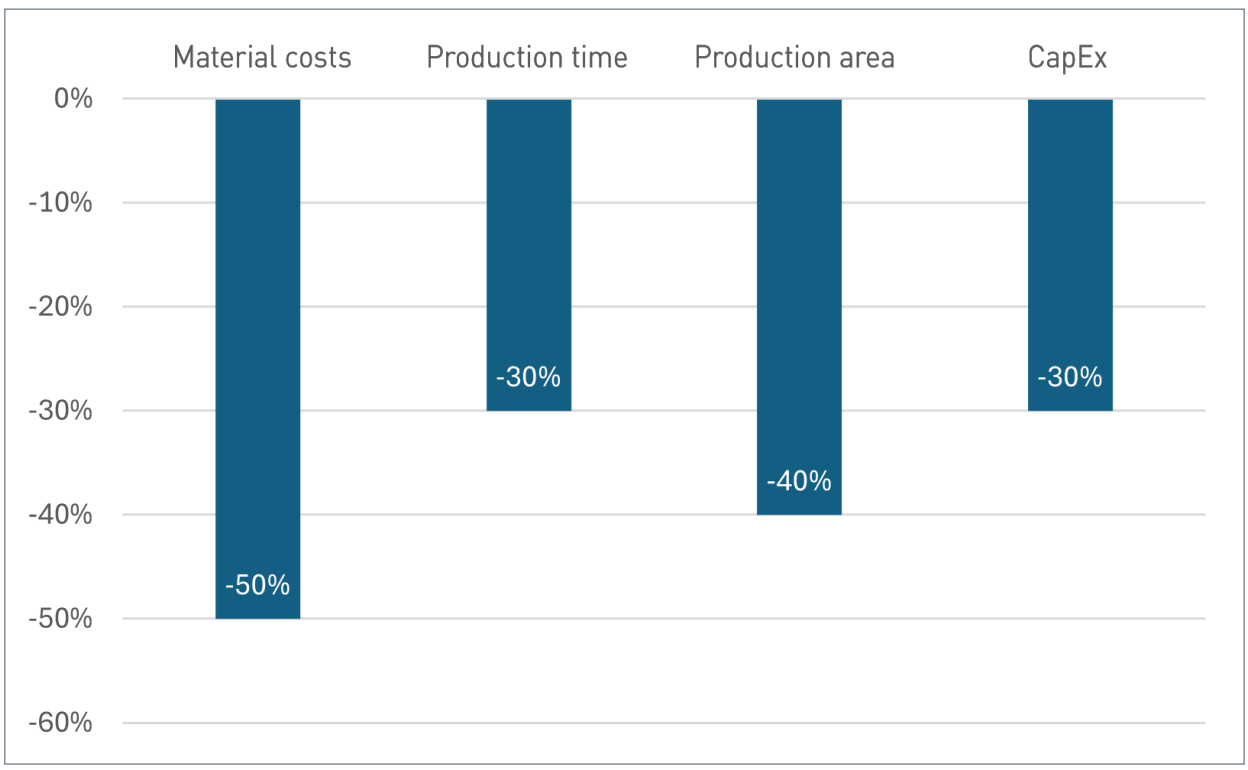

Figure 2: Estimated cost reductions by Tesla for unboxed concept [4]

Current trends

in automotive production

PRODUCTION TECHNOLOGY

In addition to new trends in vehicle design, new technologies for vehicle production are also evolving. This applies to the body and paint shop as well as the final assembly in automotive production. The following provides a selection of trends concerning conveyor and assembly technology in automotive production.

CONVEYOR TECHNOLOGY

Two significant trends can be identified in conveyer technology. One is the transportation of vehicles using AGVs (automated guided vehicles) and AMRs (autonomous mobile robots). AMRs differ from AGVs in that they possess autonomous functions, enabling them to make decisions independently of initial programming. This makes AMRs more robust in handling exceptional situations compared to AGVs, although their behavior is not fully predictable, which can lead to unreliabilities [14]. Many applications are already implemented in the industry and are being further developed.

Another trend in conveyor technology for BEV final assembly is the so-called rolling chassis. The idea is that the vehicle itself moves through the production once it is capable of doing so, based on the assembly and commissioning progress. This has the potential to significantly save on CapEx in conveyor technology. However, to enable this in production, the production areas need to be appropriately prepared, and safety measures must be considered.

ASSEMBLY TECHNOLOGY

The main technology trends in assembly are in the fields of humanoid robots and artificial intelligence (AI). Humanoid robots are designed to resemble and perform tasks in a manner similar to that of a human, including human-like dexterity and mobility. They are designed to interact with their environment and perform various functions in a way that is similar to human capabilities. [15] Several companies have already introduced prototypes. Boston Dynamics, for instance, introduced a new version of its robot Atlas in April 2024 [16]. These robots have also attracted the attention of car manufacturers. Tesla has developed a humanoid robot, Optimus [15]. BMW has announced a partnership with the Californian start-up Figure to explore applications for humanoid robots in its Spartanburg, South Carolina production plant[17]. While widespread deployment does not appear imminent, production should get prepared to integrate these robots on a wide scale once they reach market readiness.

Artificial intelligence involves using machine learning models to gain knowledge from data or generate new content based on patterns and information from a given dataset. These models can create new outputs, such as images, text, or even entire designs, by learning and replicating patterns from the training data, often leading to novel and creative outputs. The technology gained widespread attention with the introduction of ChatGPT. In production, numerous use-cases for the application of AI are already apparent. For instance, AI can optimize processes by generating and simulating various assembly scenarios, allowing managers to enhance workflow and resource allocation. It can also support customized production by designing custom jigs, fixtures, and tools tailored to specific product or part geometries using generative models. Furthermore, AI can be utilized for robotic path planning, enabling robots to navigate intricate routes and make decisions during assembly, thereby enhancing efficiency and reducing errors. Consequently, significant potentials are expected. [18]

Current trends

in automotive production

IMPACTS ON KPIS OF PRODUCTION

All these developments aim to achieve significant competitive advantages for OEMs. These advantages can be concretized and measured based on target systems for vehicle production. Figure 3 illustrates an exemplary target system for vehicle production, which is similar for all OEMs. It encompasses aspects of time, cost, quality, resilience, sustainability, and employer attractiveness.

A reduction in production and lead time can be achieved through the modularization of vehicle architecture, enabling a higher level of parallelization of workflow steps. The deployment of technologies can significantly impact cost aspects, as potential ratios can be leveraged through automation. Enhancing quality can be accomplished by the use of AI techniques, which can observe quality-critical tasks and influence process parameters.

Resilient production involves adapting to fluctuating production volumes and changing product mix, generally referred to as flexibility. AI can support this by enabling robots to adapt paths to new variants in real-time without manual programming. Another significant aspect of production resilience is changeability, where an entire plant and its associated production processes can adapt to changed conditions, such as the introduction of new products, over time. This is where the modularization of the vehicle architecture offers significant benefits, potentially reducing the need for monolithic manufacturing facilities and aligning product development cycles with factory adaptations.

New vehicle architectures designs can also impact production sustainability. According to Tesla, the factory footprint can be reduced, and modular construction might also reduce painting work, significantly lowering energy consumption and the use of hazardous chemicals.

Positive effects are expected with regarding the employee attractiveness of production. Modular construction could allow better accessibility for carrying out assembly steps, thus facilitating work in production. Additionally, the collaboration between human workers and humanoid robots could simplify assembly tasks. These aspects could enable older employees to work longer in specific areas, mitigating the effects of demographic change.

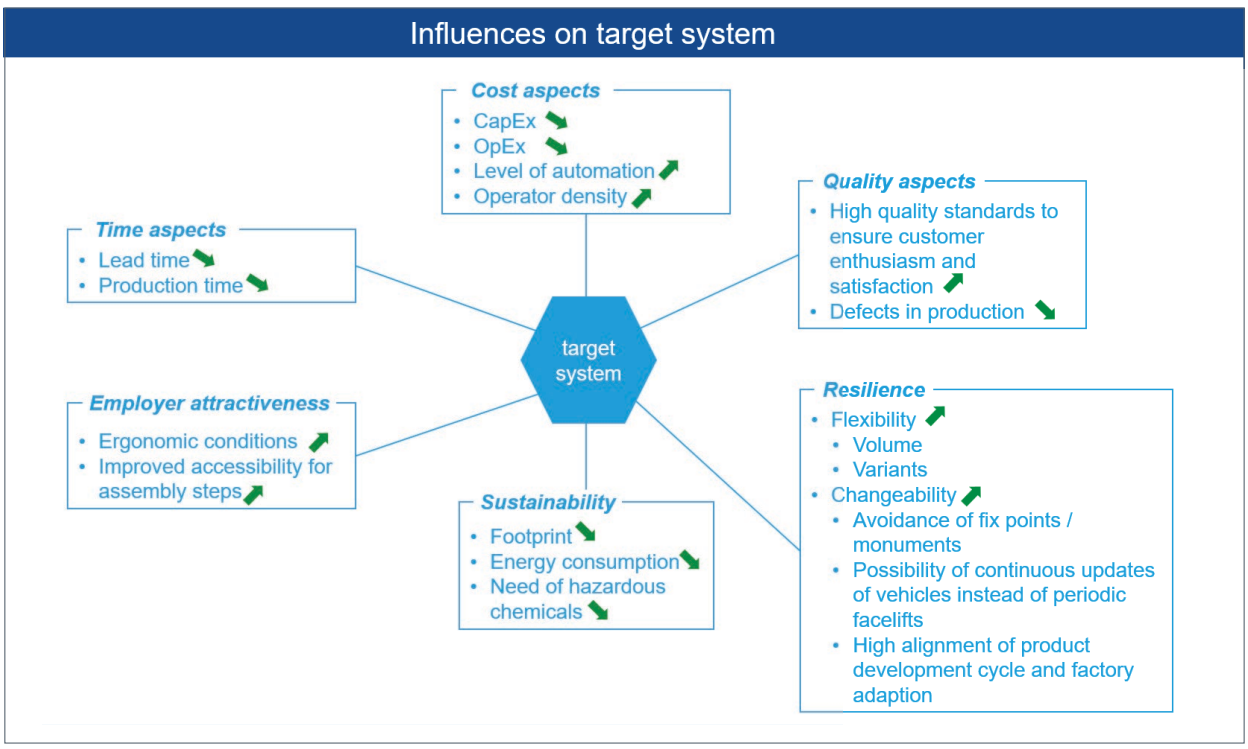

Figure 3: Potential target enhancements in vehicle production through new vehicle and production concepts

Production-Strategy Assessment

regarding New Vehicle and Production Concepts

The previous chapter demonstrates that groundbreaking technological innovations are in development and implementation. Maintaining a comprehensive overview of these trends and assessing their impact on one's production is challenging. To address this, DÜRR Consulting provides a standardized Production Strategy Assessment.
It aims to guide technological developments, assess the specific potentials of introducing new technologies for a production facility based on the target system, and derive recommendations for specific measures aligned into a cohesive and logical roadmap.

The following outlines the approach in more detail before discussing the results and benefits for the customers.

APPROACH

As depicted in Fig 4, the approach is structured in three steps.

STEP 1: DISCUSSION OF PRESENT INFORMATION

The initial step involves gathering and discussing necessary strategic inputs, including desired vehicle concepts (both conventional and innovative modular vehicle concepts), targeted volumes, sales markets, and intended production locations. DÜRR Consulting then provides an overview of new technology trends, based on the DÜRR Technology Radar, covering various aspects such as assembly technologies, conveying systems, and AI procedures.

STEP 2: DEVELOPMENT OF SCENARIOS

In the second step, new high-level production scenarios for the body and paint shop, as well as the general assembly, are developed based on the OEM's vehicle concepts and technology trends. Depending on the scope, these may include production concepts for existing brownfields or new greenfield sites. For brownfields, it is particularly intriguing to analyze whether new vehicle architectures can even be produced in the existing manufacturing facility, and if so, what conversion measures would be necessary.

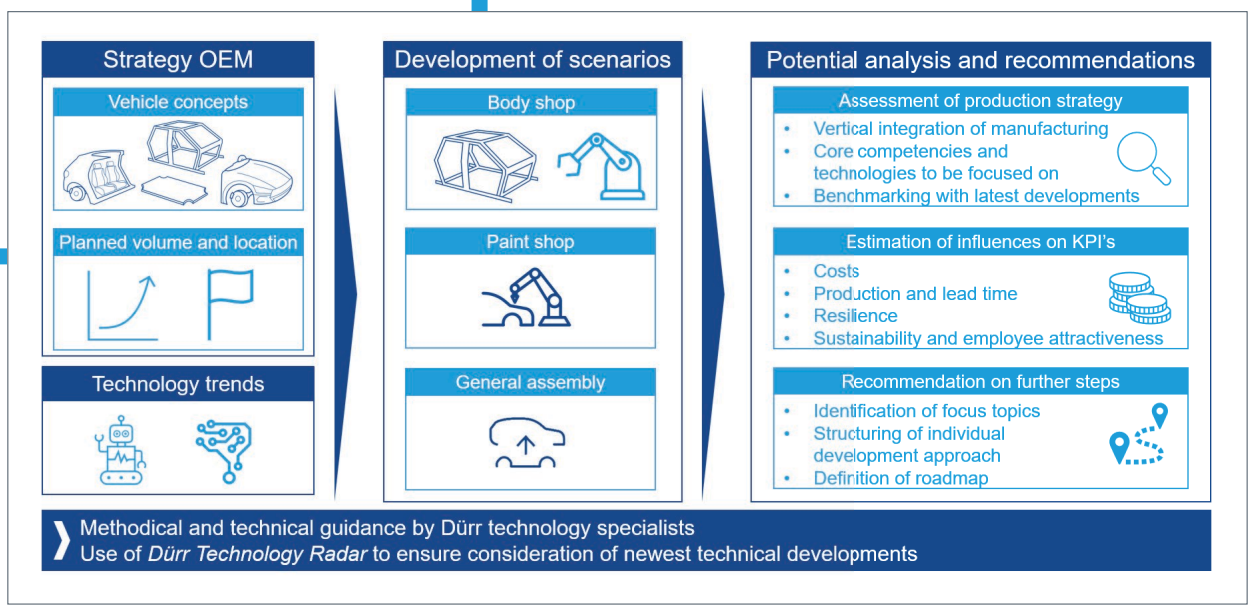

Figure 4: Approach of the Production Strategy Assessment "New Vehicle and Production Concepts"

Production-Strategy Assessment

regarding New Vehicle and Production Concepts

STEP 3: POTENTIAL ANALYSIS AND RECOMMENDATIONS

The third step involves reviewing the existing production strategy and deriving necessary adjustments. This might involve adjusting the level of manufacturing depth or considering new core competencies. Potential analyses based on the created production scenarios can be conducted regarding KPIs. Depending on the target system, it can be determined how objectives may change through the introduction of new trends, such as estimations of space requirements or production times. Based on these insights, specific developmental steps for revising the production strategy can be derived and organized into a roadmap based on priority and temporal dependency.

The entire strategy assessment is led and accompanied by DÜRR automotive and technology experts to ensure a systematic approach and the transfer of technological know-how.

RESULTS OF ASSESSMENT AND BENEFITS FOR CUSTOMER.

As a result, the customer receives initial high-level production scenarios for their vehicle architectures, including consideration of new technologies. They also get an analysis of their production strategy with recommendations for adjustment, providing a proactive strategic outlook.

The customer benefits from exclusive insights into the latest developments in the automotive industry, particularly innovative vehicle architectures, and analyzed potentials related to new vehicle architectures. They also receive benchmarking of their technologies against the latest advancements and recommendations for adjusting the production strategy from external automotive and technology experts.

Conclusion

Significant developments are taking place within automotive production. It is important to be aware of the trends, both in terms of changes in vehicles and new production technologies. Observing these trends and assessing their relevance is essential, requiring continuous review and adaptation of one's strategy. This necessitates a good overview of market developments. As part of a machinery and plant engineering company, we from DÜRR Consulting can provide exclusive insights into industry developments and thorough knowledge of current technological advancements.

This makes us the ideal partner to review your production strategy and align it with future needs.

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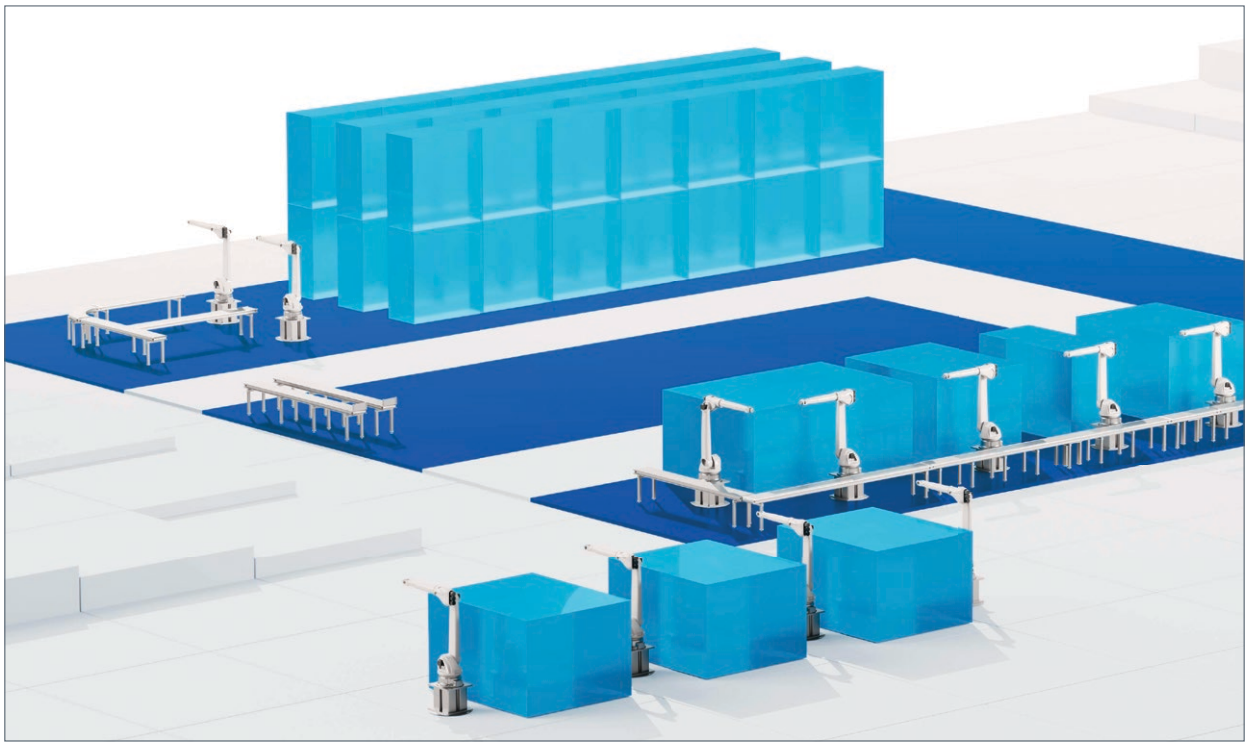

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