Future readiness in automotive production

Holistic reorientation for cost-efficient production

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Roland Berger

Introduction: How to build the plant of the future (1/2)
A holistic view of all relevant factors is the key to cost-optimized production

The automotive industry is struggling. Compared to others, it has been particularly badly hit by the current global economic turmoil and challenges such as Covid-19, the semiconductor shortage, unstable supply chains and rising costs. Overall vehicle purchases in the first half of 2022 were 2% down on the second half of 2021, for example, although manufacturers were able to improve their results due to reduced discounting.

OEMs also face many industry-specific challenges. Primarily, they must transition their entire business to electric vehicles (EVs) while continuing to offer internal combustion-engine (ICE) vehicles. In addition, new, agile EV players from North America and Asia, unburdened by old buildings and inflexible legacy processes, costs and structures, threaten their market share.

Traditional players must reinvent themselves or clear the field for more dynamic rivals. To be fit for the future, selective optimization or switching supply chains is not enough – product and manufacturing concepts must be holistically rethought. OEMs need to be able to respond to volatile demand and supply, as well as ensure highly efficient production and operations functions that can implement innovations. At the same time, because of the financial strain of producing both ICE and EV vehicles, they must improve their competitive cost position.

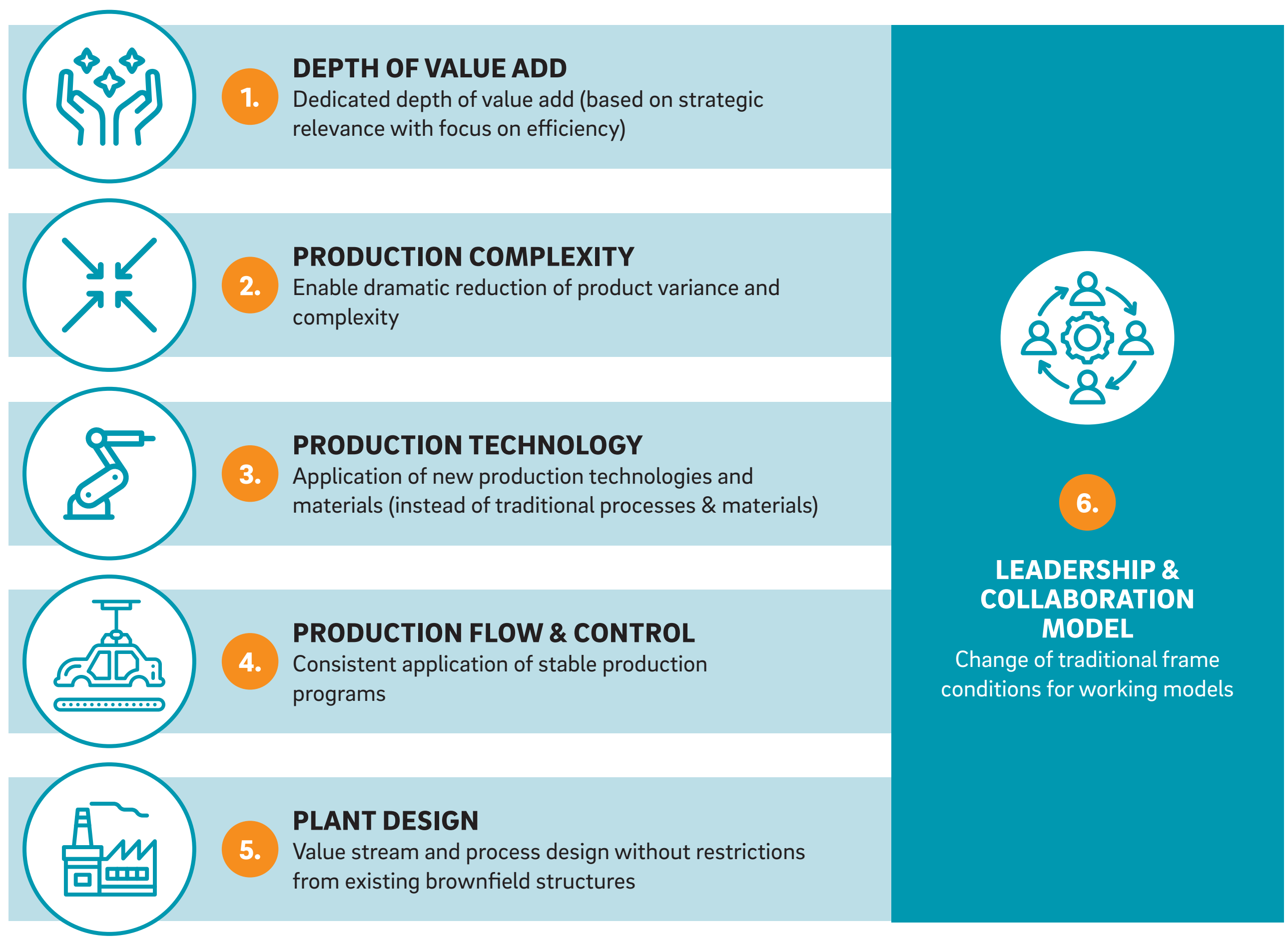
Introduction: How to build the plant of the future (2/2)
A holistic view of all relevant factors is the key to cost-optimized production

We believe six success factors are key to holistic reorientation for cost-effective production: depth of value add; production complexity; production technology; production flow & control; and plant design. In addition, these will depend on an enabler – an effective leadership and collaboration model, with strong decision making.

In this report, we assess each factor, including asking:

- Which factory archetypes should automotive players focus on?
- To what extent are new product concepts determined by product development and sales?
- How much of the voice of manufacturing should be allowed in product design?
- What is the impact of new production concepts on production design and complexity?
- What are the opportunities for new technologies and materials?
- Which production footprint is the most suitable?
- How does company culture need to adapt to new concepts?

SUCCESS DIMENSIONS
Our six dimensions to make the plant of the future more effective and efficient



Source: Roland Berger

1. Depth of value add
Value creation depends on having the right strategy, partners and digital tools

The depth of value add should be primarily geared towards future competitive advantage.

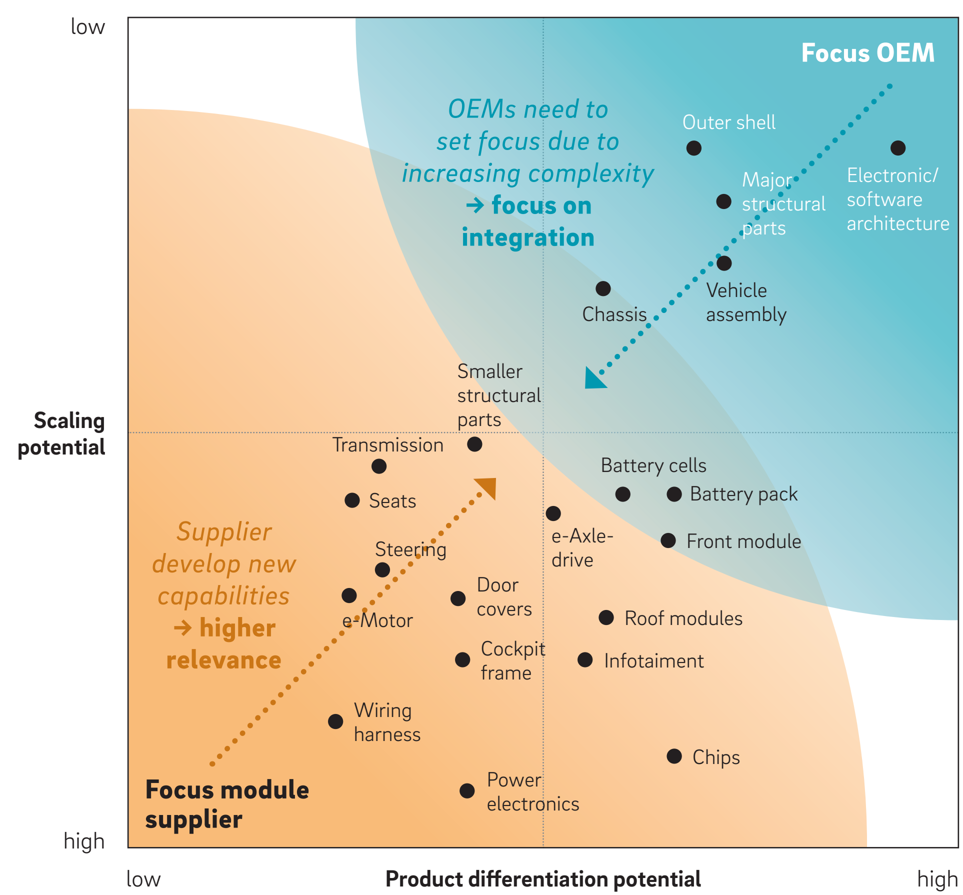
A key factor in the transition from ICE vehicles to EVs is to shift away from legacy thinking. Rather than relying on historic processes when planning for the future, OEMs must instead ask themselves whether something makes sense from a strategic point of view. Focusing on selected issues will allow automakers to use scarce resources more efficiently, and create the headroom for the transition.

The transitions to EVs also raises the question of which manufacturing scopes OEMs should do themselves, and which should involve partners (see graphics). The more functions an OEM can perform, the greater its independence from supplier risks. But with automotive technology becoming increasingly complex, it makes sense for OEMs to develop strategic partnerships with suppliers.

Partnerships with suppliers offer access to manufacturing technology, process and material innovation and cost reduction levers. The OEM can thus close gaps in its own technology and increase its competitive strength. OEMs could even outsource entire modules, such as discontinued ICE components. To make partnership deals work, OEMs must ensure they have a good overview of the supplier and technology market in order to assess their development status and identify opportunities for vertical integration.

Lastly, supply chain transparency across the value chain using digital tools, enables internal value creation efficiency, as well as controlling end-to-end processes.

FOCUS OF VALUE-ADD FOR AUTOMOTIVE OEMS AND MODULE SUPPLIERS
(INDICATIVE ASSESSMENT BASED ON SELECTED COMPONENTS)



Depth of value add needs to be challenged to set the right focus for the future production. Various questions need to be considered, e.g.:

1. Where can competitive advantages be achieved (e.g., technology leadership for differentiating and innovative components)?
2. Where are potential supply risks? Should thus reduce dependency on suppliers?
3. Where should the individual level of complexity be reduced and strategic partnerships developed?

Source: Roland Berger

2. Production complexity
Level of complexity should be determined by what is manageable for the plant

In recent years, the number and variety of products used in automotive plants have skyrocketed, with parts now sourced all over the world. This drive to offer more choice has vastly increased production complexity, which can account for a fifth of total product costs.

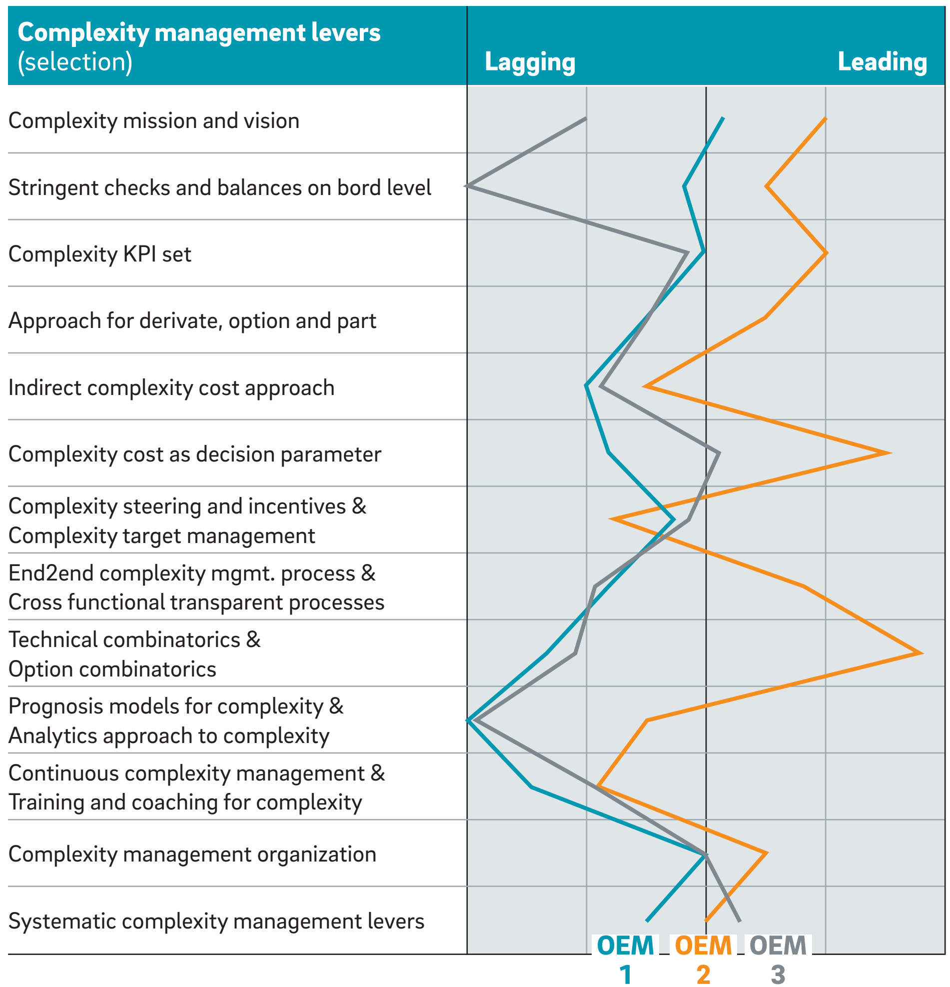
However, new EV players have shown that customers are willing to settle for limited choices, as well as longer waiting times and fewer opportunities to change. There is, therefore, an opportunity for OEMs to reduce complexity while improving production. Determining what is feasible in a plant, and improving its efficiency, are the key.

Plants that are not fully utilized tend to underperform, while those that produce multiple platforms for multiple vehicle models are usually expensive. To improve the efficiency and manageability of both, production of vehicles with comparable body structures should be focused in one plant, and product diversity limited. A high share of common parts has been shown to reduce production errors and rework.

Product changes are another key target. Late changes are costly and tie up production and logistics capacities needed elsewhere. Robust decision making is therefore critical. For example, strict design freezes need to be implemented from the outset.

In the longer term, new infotainment services such as Function on Demand will be improved. These could help to differentiate offerings in the market and generate new revenues, while further reducing production complexity by content harmonization.

COMPLEXITY MANAGEMENT CAPABILITIES BENCHMARKING OF SELECTED OEMS



Source: Roland Berger

Complexity management is a key game changer for future cost down activities – nevertheless maturity within most OEMs is still not very high.

Necessary actions are:

1. Manage complexity along the entire lifecycle by all involved functions
2. Establish a controlling model including all costs
3. Form an organization which is capable to manage complexity and ensure PDCA
4. Use tools which give transparency, good prognoses and hilp to optimize complexity early

3. Production technology
Innovative new technologies will underpin future automotive production

New technologies will be the backbone of future automotive plants, with the key levers based around data tools, robots and new approaches to old problems.

While plants have been collecting vast amounts of production data for years, it has rarely been used to aid operations. New data-driven tools are changing this, for example by helping to make maintenance much more efficient. Instead of using fixed maintenance intervals, a machine and its performance is constantly monitored to predict the next maintenance over its lifetime using self-learning algorithms. Such self-learning algorithms are also used in automated quality control, where sensor and process data is analyzed to identify anomalies and optimize product quality.

Developments in sensors, artificial intelligence (AI), haptics and real-time connectivity within the factory have also led to advances in human-robot interaction. For example, unmanned aerial vehicles and automated guided vehicles can help to improve flexibility and ensure a continuous, safe and efficient flow of parts and materials.

Across the new technologies, manufacturers are also increasingly tapping into the know-how of equipment manufacturers to provide novel solutions to problems and reduce costs. Similarly, new EV players have shown how important it can be to completely rethink product concepts and production technology. This is an area where forward planning, quick decision making and courage to take risks really help, as better and more cost-efficient solutions are coming online all the time.

INNOVATIVE BUILDING BLOCKS FOR PRODUCTION TECHNOLOGIES

	Component manufacturing	Press Shop	Body Shop	Painting	Assembly	Inbound & intralogistics
A Advanced Manufacturing Technology (e.g., High-pressure die casting, 3D-Printing)	Medium	Medium	Medium	Low	High	Low
B Machine Parameter Optimization (e.g., automated setting and optimization of process parameters)	Medium	High	Medium	High	Low	None
C Data-driven Machine Maintenance (e.g., predict remaining useful lifetime instead of fixed maintenance intervals)	High	Medium	High	Medium	Low	None
D Automated Quality Control (e.g., Vision-based quality inspection and automatic repair)	High	Medium	High	High	High	Low
E Human-centric Assistance Systems (e.g., "data-glasses" for control tasks or work instruc-tions and ergonomic assistance systems (exoskeleton))	Medium	Low	Low	Low	High	Medium
F Autonomous Material Supply (e.g., automated picking and kitting, use of UAVs/AGVs for autonomous material flow)	Low	Low	Low	Low	Medium	High

Relevance (based on # of use cases identified in interviews conducted by Roland Berger in context of Industry 4.0 study): None Low Medium High

Source: Roland Berger

4. Production flow & control: Robust supply chains, stable production and new technologies all help to ensure smooth production flows

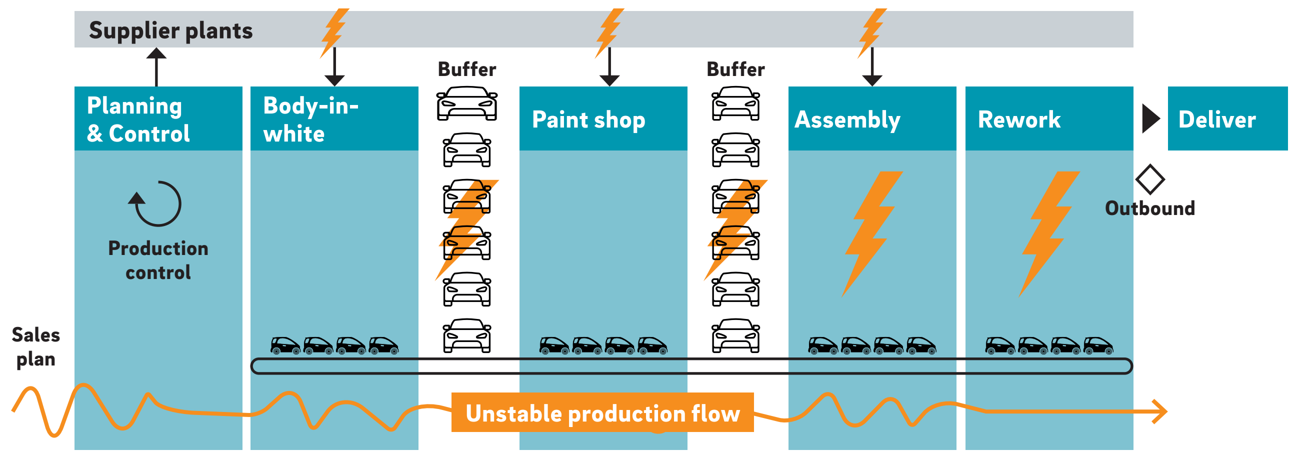
Robust oversight of production flow and control helps to optimize operating expenses and minimize disruptions caused by internal factors. Smooth flow depend on several factors.

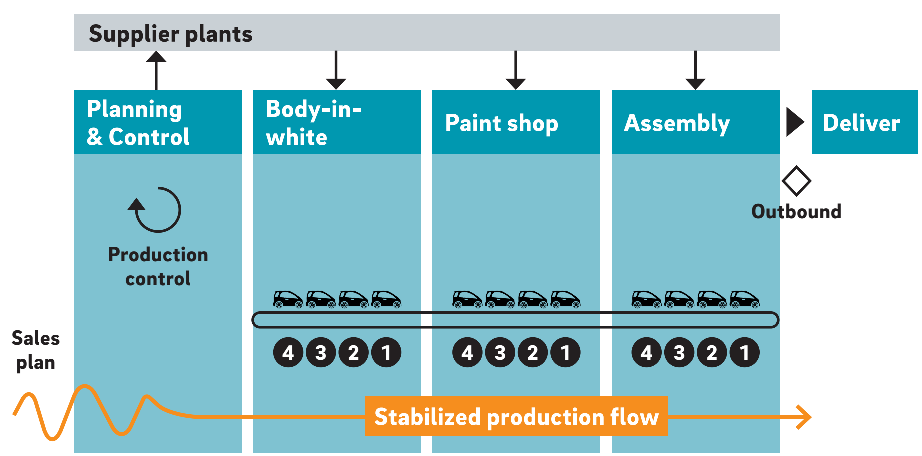
A stable supply chain is the backbone of any organization, helping to manage risk and enhance productivity. A commitment to stable production and internal logistics (material handling, warehousing) is therefore key. This could involve: an agreed production plan (for example (see graphics), an extended program freeze period of two weeks, no changes allowed etc.); a supply-chain 'tower' to track and trace parts and ensure quality; the removal of sorting buffers between technical areas; and a strict limit on outline rework locations to avoid expensive reworks.

A focus on quality in all production steps is also crucial to smooth flows. It helps to reduce line stoppages and expensive reworks, while a strong quality management philosophy ensures the implementation of quality tools, processes and technologies.

Meanwhile, digitalization and new technologies are set to revolutionize production processes. The digitalization of operations ensures transparency across the value chain and enables quick decision making, while a connected shopfloor generates process data that can be used to improve equipment performance. And new technologies such as quantum computing will in the future help to optimize production control by, for example, ensuring robust scheduling and avoiding supply-chain disruptions.

EFFICIENT PRODUCTION REQUIRES A STABLE SUPPLY CHAIN





A stable supply chain is the backbone of any company's operations and helps to avoid risks and ensure high productivity. This includes, e.g.:

- Sales, purchasing, and logistics need to cooperate in creating reliable production plans in the best interest of the company; short-term changes in production plans cause enormous turbulence and tie up resources in the organization without any real improvement
- Ensure transparency throughout the supply chain to respond appropriately to any disruptions in advance - digital tools for track & trace help to keep the reins of action in your hands

⚡ = Potential reason for unstable production flow

Source: Roland Berger

5. Plant design: Greenfield or brownfield doesn't matter. Sustainable plant concepts must be freed from limitations to ensure optimal flow

For years, OEMs have integrated new products into existing space and structures, accepting brownfield constraints. While cheaper in the short term, this lowers competitiveness due to unstable processes, less optimal production flow, high manufacturing effort and sprawling costs and reduces production space efficiency i.e., the actual space utilized for production against the total available space. The transition to electrification must be used to rethink.

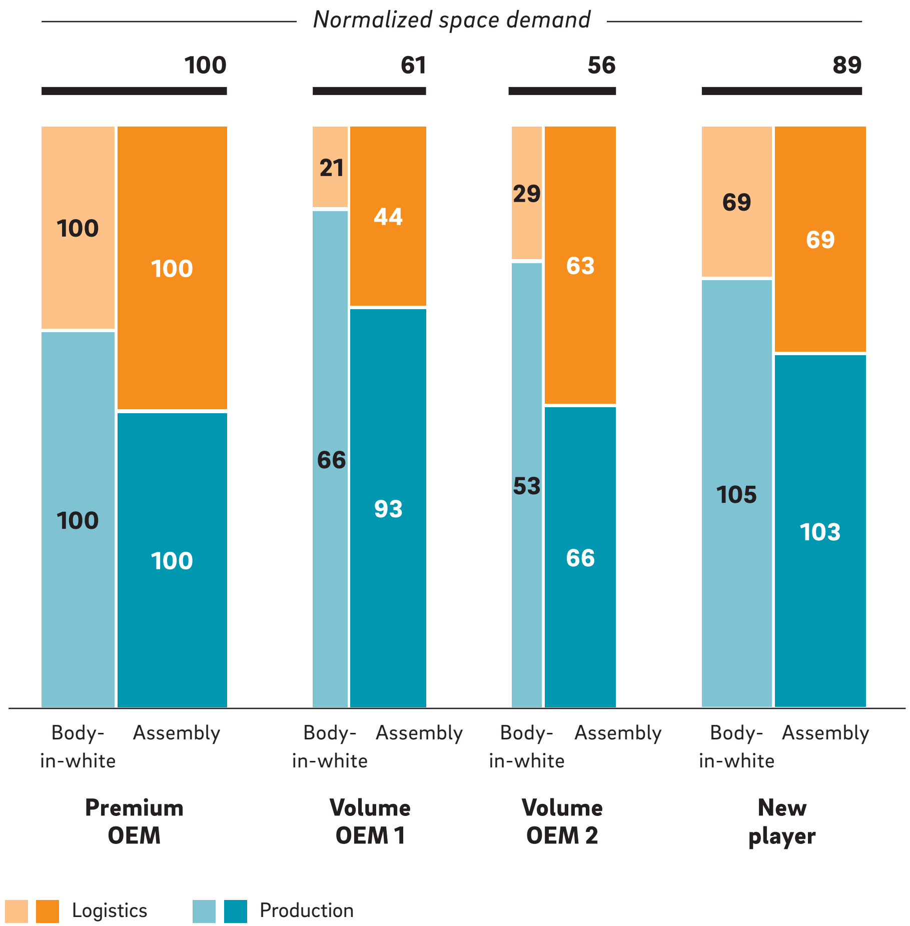
Factories built on new (greenfield) sites allow the implementation of new, leaner production and logistic concepts that offer straight-line production and better cost efficiencies. Brownfield sites still have a part to play, but existing restrictions need to be fully considered and a focus placed on freeing up space.

Concepts should be aligned with the production mission. Plants with different vehicle platforms require flexibility to react to volatility in market demand. Plants with limited vehicle models on similar platform need to be designed towards standardization for maximum efficiency. This should include building in flexibility to accommodate volume swings, and ensuring module production and pre-assembly take place near to the main plant.

Material supply, conveyor systems and warehouses are also critical for a cost-optimal plant design. To ensure CAPEX and operational efficiencies, logistics should follow three principles. Direct delivery of goods to the point of use in the right quantity at the right time is most important. If this is not possible, then ensure as few handling stages as possible. Lastly, aim for maximum space utilization and do not set up buffers to conceal process problems.

OPTIMIZATION OF PLANT DESIGN WITH FOCUS ON SPACE EFFICIENCY

Benchmarking of space requirements by production phase (% share of total area)



LESSONS LEARNED:
(Excerpt)

Cost-sensitive OEMs apply ...
- higher worker & equipment density
- simpler production processes/ technology
- lower # of assembly stations
- no reserve capacity for not confirmed products
- pre-assemblies placed outside of the plant

Cost sensitive-OEMs and New Player apply ...
- reduced # of product variants
- higher proportion of direct delivery to avoid handling steps
- smaller buffers

Source: Roland Berger

6. Enabler: Leadership & collaboration model
Management must rethink ways of working as part of the transition to electric vehicles

The process of change in automotive production is linked to electrification. But it is not just about switching to a new drive technology. Rather, it is a matter of strategically scrutinizing the entire company, repositioning it, building up new expertise and capabilities, and developing new competitive strengths. Most companies underestimate the impact of strong leadership & collaboration models on their whole operational performance. Four levers are essential:

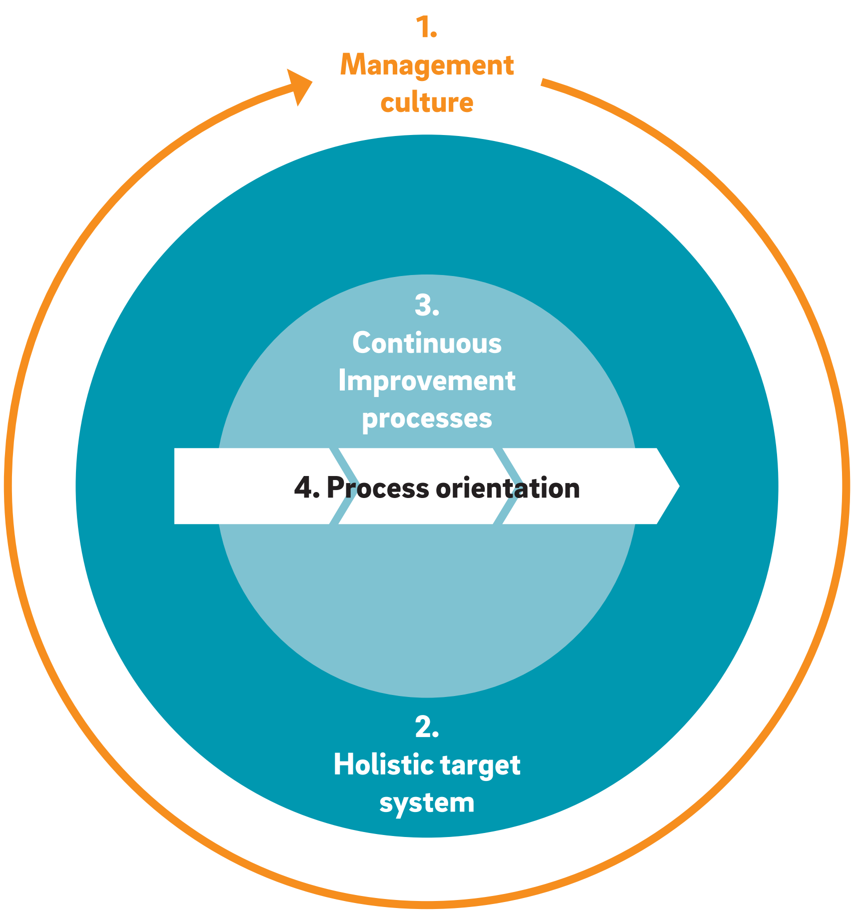
A strong management culture: The entire team needs clarity about the new goals, so develop a winning target picture to motivate them. It is also important to question existing structures, rethink limiting factors and promote new approaches to solutions with reliable decisions. In addition, operational excellence must be made the key virtue, with a new overarching operating system.

A holistic target system: To avoid silo working and loss of focus on overall goals, management and departments should commit to what's best for the company. This means operationalizing and translating the corporate strategy into concrete goals, which are hierarchically structured, prioritized and backed up with KPIs.

Continuous improvement processes (CIP): Management must demand ambitious CIP and actively participate in optimization activities. Initiatives set up across departments and functions will have the greatest and most sustainable effect.

Consistent process orientation: A process-oriented organizational structure helps to address responsibilities more clearly and improve decision quality and speed. Key company figures must be assigned to processes to monitor their effectiveness.

FUTURE READINESS REQUIRES A STRONG LEADERSHIP & COLLABORATION MODEL



"Implementing a successful leadership & collaboration model requires the involvement of the entire organization"

Source: Roland Berger

Key takeaways for future readiness in automotive production

- The levers to effect cost-efficient production are mostly known across industry but remain dormant

- Holistic optimization across each and every perspective is more effective than focusing on individual aspects

- Future readiness is not simply a question of brownfield or greenfield

  - Brownfield plants offer a significant range of cost optimization opportunities if the entire range of impact factors of perspectives is applied

  - Greenfield plants have fewer constraints to consider therefor maximum focus should be on streamlined flow of production and material

- The key to holistic optimization is the cross-functional collaboration of all parties in the organization, and challenging existing approaches

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