



► Modularization in Industrial Goods

A framework to master
increasing complexity

INSIGHTS

//01

Comparably low volumes and high variance typically characterize the industrial goods sector. The demand for custom- and use case-specific solutions is increasing rapidly

//02

Applied in a smart way, modularization helps industrial goods companies to increase customization while reducing complexity costs. EBIT improvements of 3–9 percentage points are possible

//03

The key to a successful realization of modularization is the often underestimated implementation of effective governance, processes, and methods

//04

The five elements framework anchors modularization deeply in the DNA of industrial goods companies. A hybrid approach ensures sustainable implementation while achieving quick wins

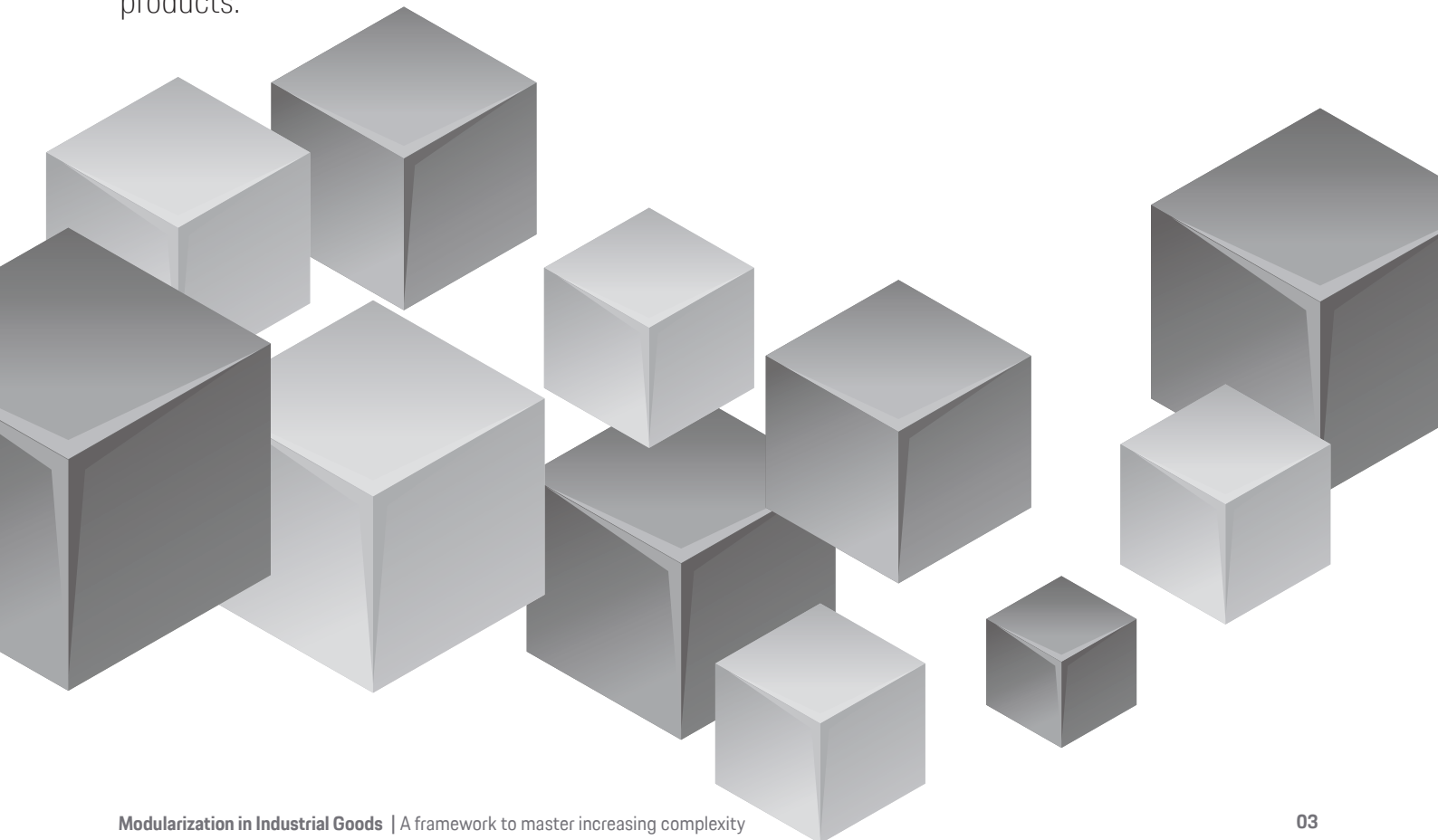
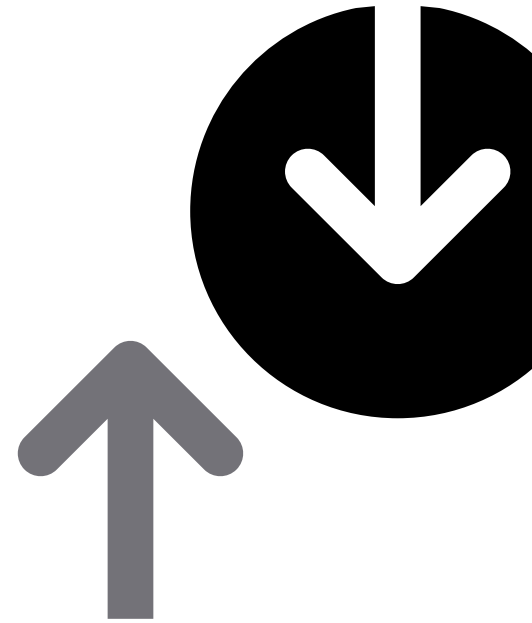
//05

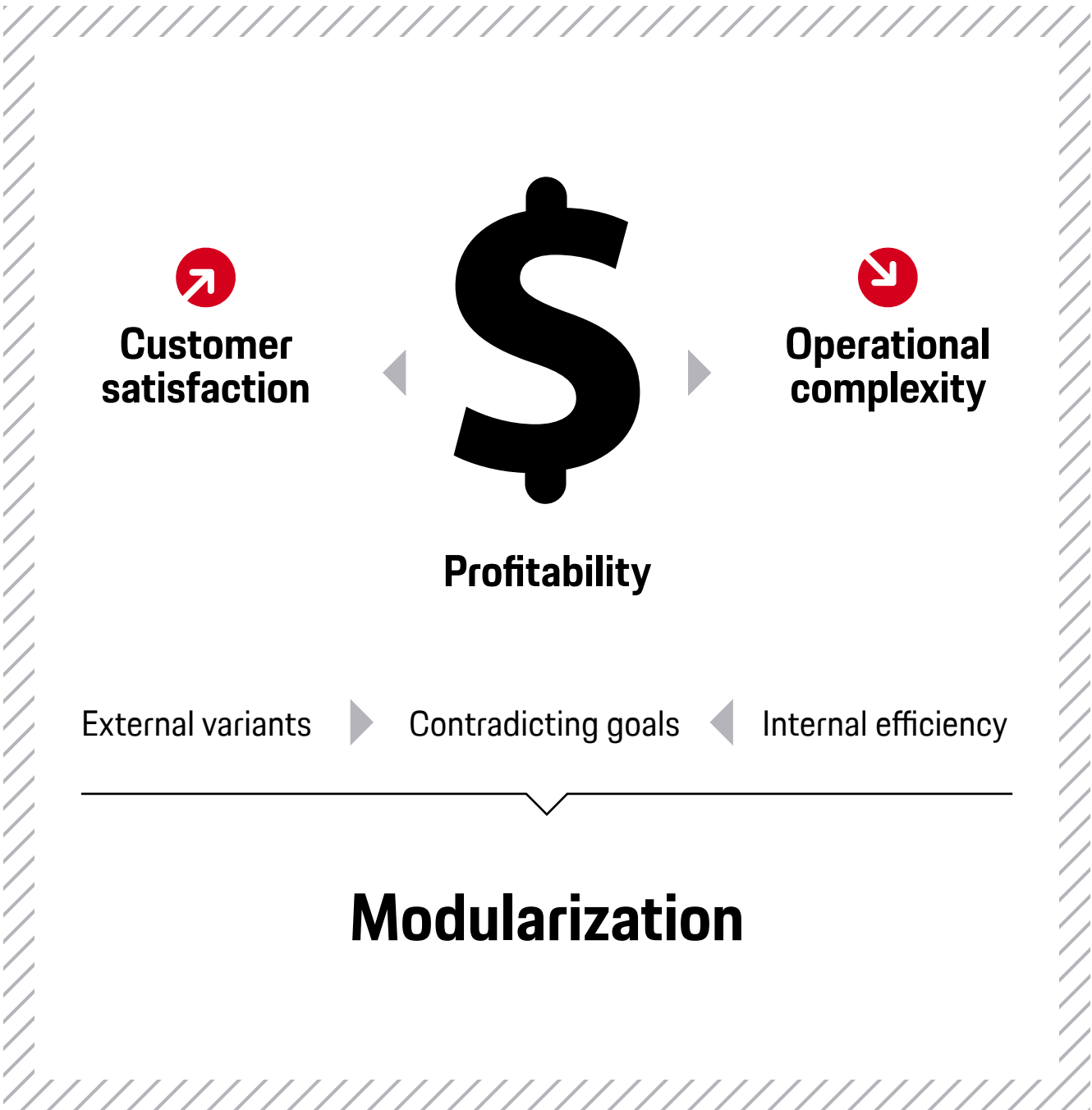
To find out more about your current modularization maturity level, just start the self-assessment and you will receive a free evaluation

01

Modularization expectations and downsides

"Citius, altius, fortius"—Latin for "faster, higher, stronger"—is not only the original Olympic motto but also the central dogma for prospering companies. Translated into business, it means responding faster to customer needs and meeting the highest expectations with excellent individualized products. The downside: individually developed and produced products lead to more variants and increasing complexity, which causes additional costs and reduces profits. Typical cost drivers are development hours for ETO (engineer to order) products, higher material costs due to lower quantities, or an increased effort for the production or assembly of customized products.





© Porsche Consulting

Fig. 1. Profitability is ensured by increasing customer satisfaction and reducing complexity

Modularization helps to reconcile the often conflicting goals of customer demand for more variance and an optimized product portfolio with low complexity (see Figure 1). Porsche Consulting has developed a holistic approach to introducing and maintaining modularization. Technical aspects such as product strategy, module strategy, and modular product structure have to be covered. At least as important are processes, governance, IT systems, and financial evaluation, which are often underestimated or even forgotten but essential for sustainable implementation.

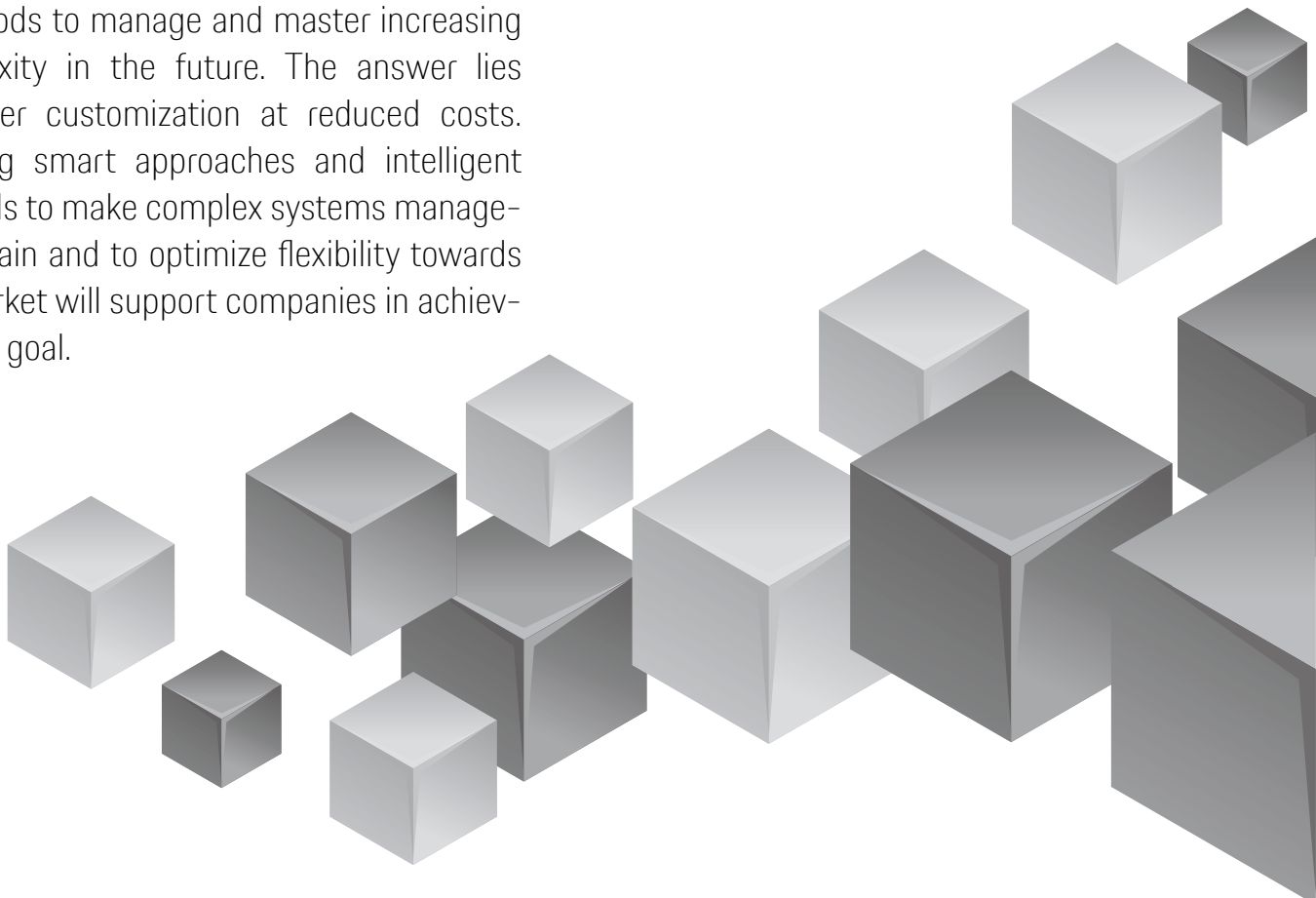
A survey has shown that companies primarily see technical implementation in many cases as one big challenge in the introduction of module management. The projects carried out in the industrial goods industry have shown that modularization can be realized in any industry. Engineer-to-order products benefit from reduced engineering effort; the advantage for make-to-order is product cost reduction due to lower internal variance. However, due to the specific business model, the degree of modularization/standardization may vary.

02

Why modularization helps to increase profitability

The industrial goods sector is facing rising costs due to higher product complexity

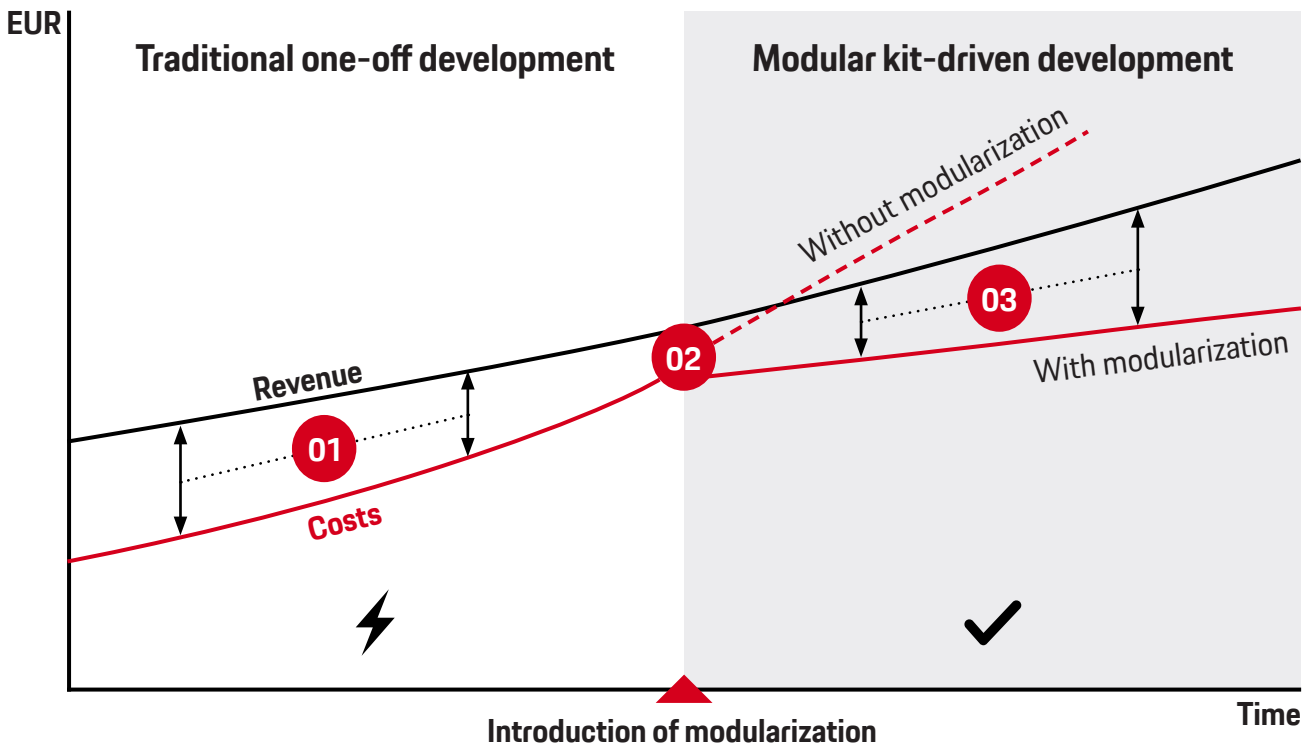
In recent years, there has been an increase in product variance and shortened innovation cycles. Also in the industrial sector, customers are expecting highly customized products and solutions for their applications, no matter whether they are purchasing a tractor or an individually developed machine. As a result, most industrial goods companies are facing an expansion in the variety of parts, which leads to high complexity costs. In contrast to the automotive industry, the industrial goods sector often deals with much lower volumes. Modularization will be key for industrial goods to manage and master increasing complexity in the future. The answer lies in higher customization at reduced costs. Applying smart approaches and intelligent methods to make complex systems manageable again and to optimize flexibility towards the market will support companies in achieving this goal.



Modularization saving levers enable an EBIT increase of 3–9 percentage points

Compared to traditional one-off developments, the introduction of modularization has positive effects on several clusters along a company's P&L. With one-off developments, rising complexity and increase of product variance lead to overproportionally growing costs and therefore decreasing consolidated profit (see Figure 2). The introduction

of modularization aims to enable variance while development costs and complexity costs stay manageable (see Figure 3). Modular kit-driven developments can even lead to long-term stabilization of the cost situation and an increase of profits within a foreseeable period (Figure 4).



© Porsche Consulting

Fig. 2. Positive revenue and cost effect by introduction of modular kits

The successful implementation of a modularization strategy offers several short- to long-term advantages and benefits for industrial goods companies. Based on Porsche Consulting's experience, modularization enables EBIT increases of 3–9 percentage points.

In the short term, there is the benefit of cost reduction: modularization allows companies to reduce the complexity of their products and increase the overall degree of standardization while still offering customers a huge portfolio. By reducing the

complexity, scale effects can be realized even with the typically lower product volumes within the industrial sector. Better planning possibilities, reduced tooling costs due to clever design, and optimized manufacturing costs are achieved internally as well as at suppliers. Impacts on stock levels and lead times are a positive side effect. Development effort and costs are reduced significantly compared to one-off product development, as major components are developed only once and not for each individual product.

Top 3 cost-saving levers due to modularization

	EBIT points earned
01 Lower direct material cost	~2–6%
02 Reduced manufacturing cost (direct and indirect production cost)	~1–2%
03 Reduced cost for order engineering and investments	~0–1%

© Porsche Consulting

Fig. 3. Top 3 cost-saving levers

The second benefit is the possibility to achieve market growth by offering more product variants due to modular product architectures. Furthermore, customers can individually configure their products and choose out of more options from a more comprehensive configurator. Modularization offers a more streamlined value chain, a shorter lead-time within production, accelerated time to market for new products, and therefore allows companies to achieve a higher and faster market growth than competitors without a modular strategy. Even a less complex and more streamlined after sales setup is realized by applying modularization.

In a third expansion stage, modularization can act as an enabler for innovation. Modular architectures in combination with modern and connected control units offer upgrading and even upselling possibilities to companies and their customers. Customers have the opportunity to exchange modules subsequently in order to upgrade or adjust their products to their specific use cases. At the same time, withdrawn modules can be used again in other products, so that certain modules can be used multiple times. Modularization not only has short-term cost effects for the company, but can also secure competitive advantages over competitors in the long run.



Benefits



Financial benefits due to **cost reduction**



Positive Impact on **stock and investments**



Reduction on time **to market**



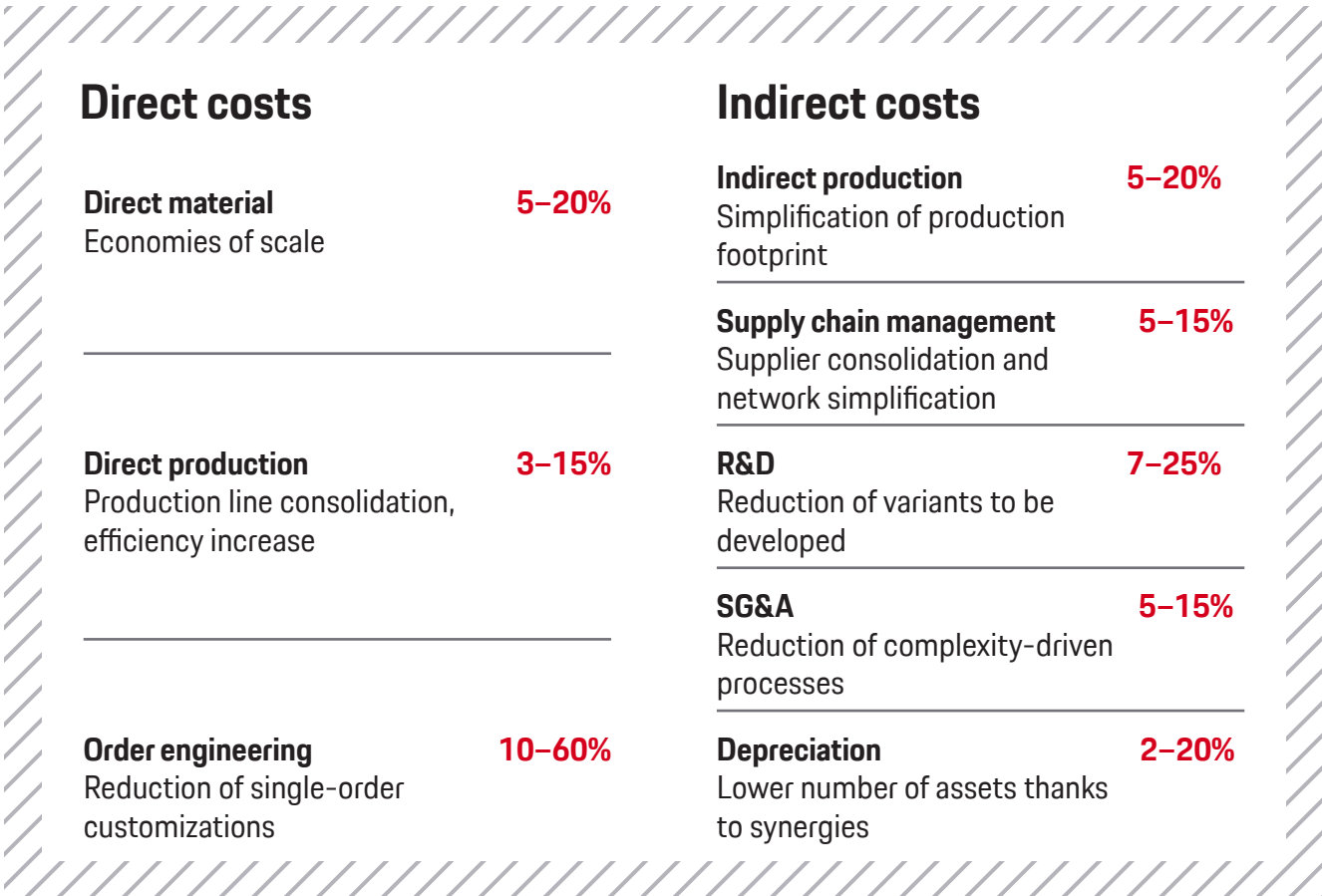
Increase of **turnover**

© Porsche Consulting

Fig. 4. Qualitative benefits of modularization

Added value for cost clusters and stakeholders

Modularization generates benefits on P&L cost items along both major clusters—direct and indirect costs. Figure 5 shows the quantitative saving potential by modularization



© Porsche Consulting

Fig. 5. Modularization potential for clusters along direct and indirect costs

Besides quantitative potential mostly relevant for shareholders, modularization also offers qualitative benefits relevant for all stakeholders of a company:

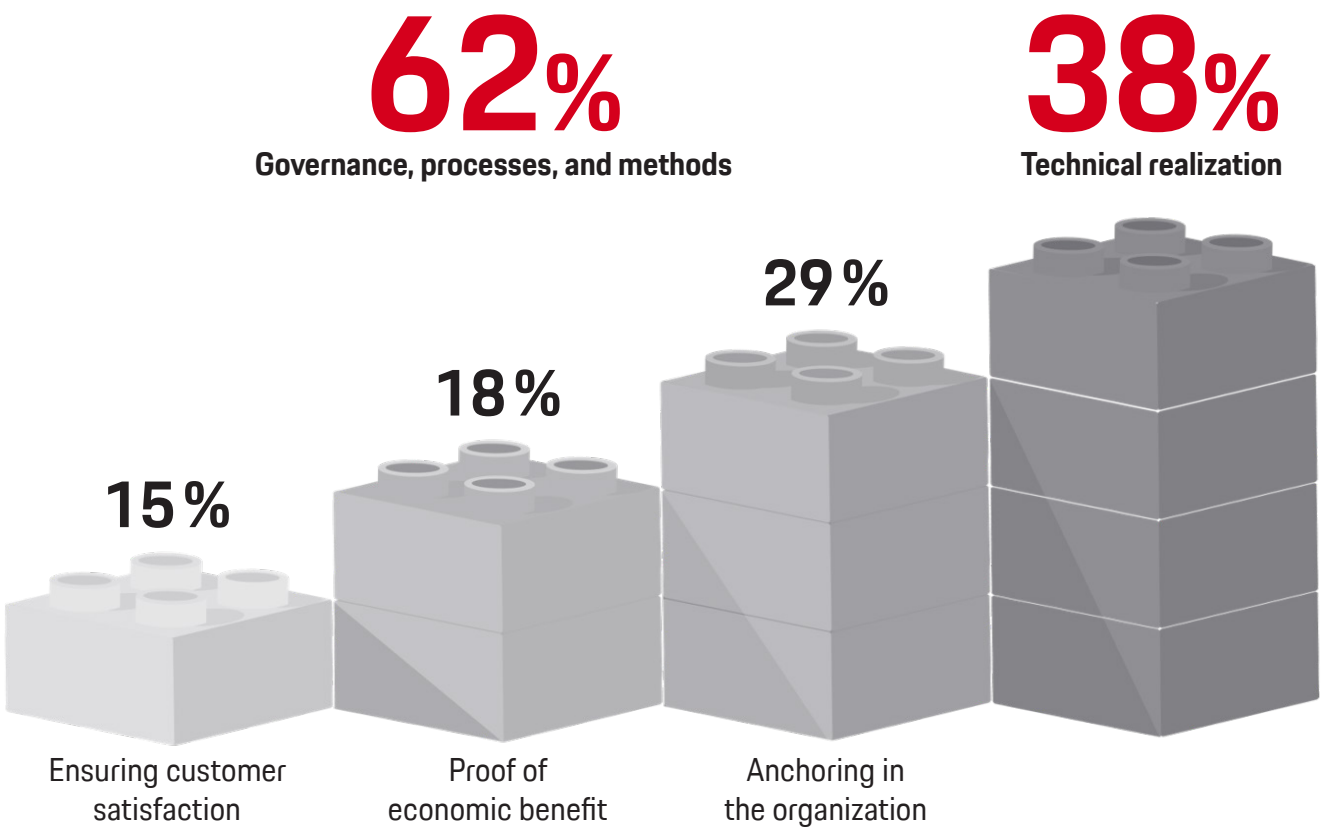
Customers/market	Shareholders	Company/employees
<ul style="list-style-type: none"> ▶ Higher differentiation in product portfolio ▶ Meeting customer requirements ▶ Better responsiveness 	<ul style="list-style-type: none"> ▶ Increased brand value ▶ Minimized risks (modular development) ▶ Reduced fixed capital and investments during product life cycle 	<ul style="list-style-type: none"> ▶ Increased work satisfaction ▶ Lean processes in entire company ▶ Clear responsibilities and competencies

Why are industrial goods companies not yet leveraging these benefits?

Porsche Consulting conducted a survey among leaders of industrial goods companies on the biggest challenges of modularization. The results show that 38 percent see technical realization as the biggest challenge of modularization—which is not surprising, as the industrial goods sector is a typical field of highly experienced engineers.

On the other hand, 62 percent see the biggest challenge of modularization in proper governance, processes, and methods as a prerequisite for ensuring customer satisfaction, proofing economic benefit, and sustainably anchoring it in the organization.

To overcome these challenges and to uncover and realize the potentials, the Modularization Framework was developed, which explains how companies need to proceed and what needs to be implemented.



© Porsche Consulting

Fig. 6. Qualitative benefits of modularization?

03

How to achieve modularization

Ideally, companies strive for the highest level of customer orientation with products based on modular kits to minimize internal complexity. In reality, however, they have to make trade-offs in pursuing their goals, such as standardizing components versus meeting specific technical requirements or legal restrictions in certain countries.

Companies define a modularization strategy as well as the modular product structure, but struggle to anchor modularization sustainably in terms of processes and organization. Consequently, original ambitions to reduce complexity in the company through modularization cannot always be realized.

Porsche Consulting's framework takes into account all the necessary elements to install and sustain modularization. In order to apply the concept, companies should develop comprehensive answers to five guiding questions:

- ▶ What products do I want to develop, produce, and sell?
- ▶ What level of modularization and standardization do I want to achieve?
- ▶ How must the product structure be set up?
- ▶ How can the organization sustain modularization?
- ▶ How can the financial benefit be calculated and ensured?



The five interlocking and equally ranking elements for modularization (in Figure 7) guide managers in answering the question of what conditions can be created to realize modularization in such a way that long-term value can be created both for the customer and for the company.



Fig. 7. Five interlocking elements of the Porsche Consulting modular kit framework

01

Product strategy—

What products will I develop, produce, and sell?

The starting point for all modularization activities is a mature product strategy, which is a cross-departmental initiative based on the corporate strategy describing the product portfolio and timeline in a product road map with regard to hardware, software, and services. Therefore, future customer requirements are classified according to standard, variant, and option, and they are systematically evaluated for all market segments and translated into functions.

In addition, future market and technology trends are fully covered in the module strategy. Since market and customer requirements can change, the process of defining the company's product strategy should be carried out at regular intervals.

02

Modular strategy—

What level of modularization and standardization do I want to achieve?

The modular strategy is a strategy that leverages the advantages of modular product architecture and includes a clear vision and targets for modularization. A clearly defined level of ambition with a bold claim further defines the targeted degree of modularization. For companies newly establishing modular management, the lead developer approach is recommended. Starting with one project, modules

are gradually implemented in all other relevant products. Another option is the on-shelf development of modular kits, which define modules that engineers are obliged to use for their projects. In a final step, a module road map is derived, taking into account the technology and product road map, to ensure deployment in the various product projects.

03

Modular product structure—

How must the product structure be set up?

The modular product structure is the detailed technical definition of the product architecture and the standardized interfaces between individual modules. It focuses on the technical implementation of the modular strategy in the product portfolio. The starting point is the architecture hierarchy with a high-level architectural tree structure. The division of functions of products or product families is required to create the module split based on dependency to

customer functions. The key element is the modules master list with all module variations for different products or product families. Finally, modules and modular kits are described and available for new products and projects to ensure that the modular product structure is practicable for current customer requirements; it must be regularly adapted to market and technology requirements.

04

Enabler—

How can the organization sustain modularization?

Since modular management is a company-wide approach, all participating departments, e.g., product management, engineering, purchasing, production, or after sales need to be involved for the development, introduction, and use of modular kits. A systematic process must be established to define, approve, develop, and control modularity in a structured manner throughout the company. This also includes the product creation process and technical change management. A central Product Lifecycle Management system and a coordinated IT landscape enable the sustainable implementation of modularization in the company. An overarching governance model must be established, because module management should ideally be managed, monitored, and controlled across the various products and product lines. In addition the supply chain strategy must also

be adapted accordingly. For basic modules, the focus is on efficiency, i.e., parts should be provided in large quantities and with low variance. In contrast, the supply of variation modules requires a high degree of flexibility, while customized modules often call for innovative suppliers who can deliver batch sizes of one piece.

05

Financials—

How can the financial benefit be calculated and ensured?

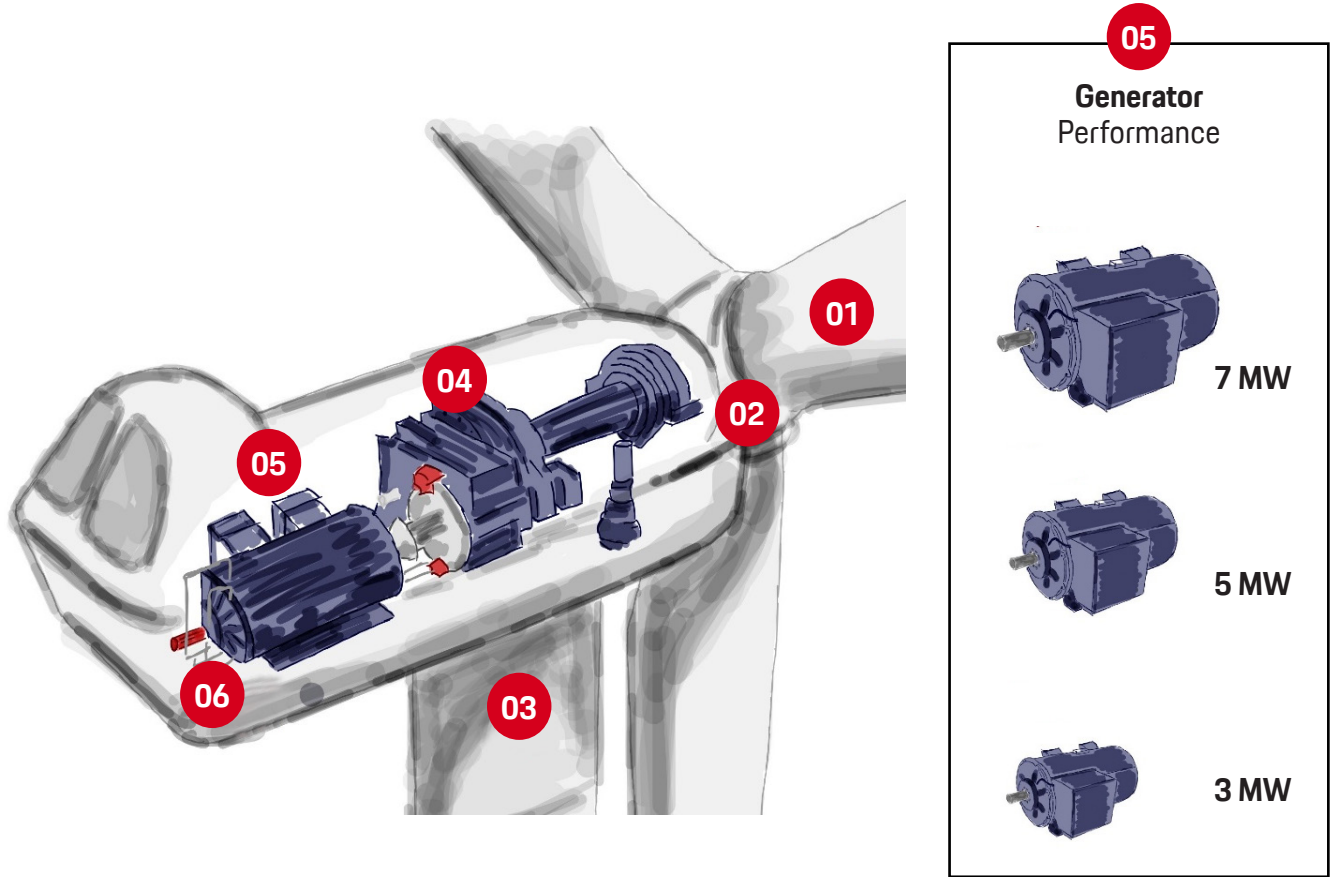
The economic efficiency of modularization has to be ensured and decisions have to be made based on financial KPIs. By intelligently allocating the necessary development budget between the developing and deploying series, the costs for module development can be reduced across the organization. However, this requires the development and consistent implementation of the module road map across all product families. For this purpose, a cost and price model has to be developed and consistently applied for the module strategy. Different drivers are taken into account in order to determine the additional effort required for the development of the modules (e.g., development costs, innovation effort) and to compare these with the synergy effects (e.g., higher quantities, lower production costs).

The development of key figure-based business cases makes it possible to evaluate and compare different scenarios in order to make an optimal business decision in regards to modularization. Finally, a specific budget has to be defined for each level of the modularity architecture.

How the modularization framework elements are applied in industrial goods

Examples show that modularization can be achieved regardless of the business model. Manufacturers of wind turbines face the challenge of offering cost-effective system solutions. Siemens Gamesa has developed different product platforms that bundle all their wind turbine products. The aim of the platform strategy is the standardization and modularization

within the product platforms to reduce production and logistics costs. Each wind turbine consists of up to six modules—such as generators or rotor blades—which can be used in different products within a platform. This allows the customer to configure wind turbines with different drive types and power classes.³



© Porsche Consulting

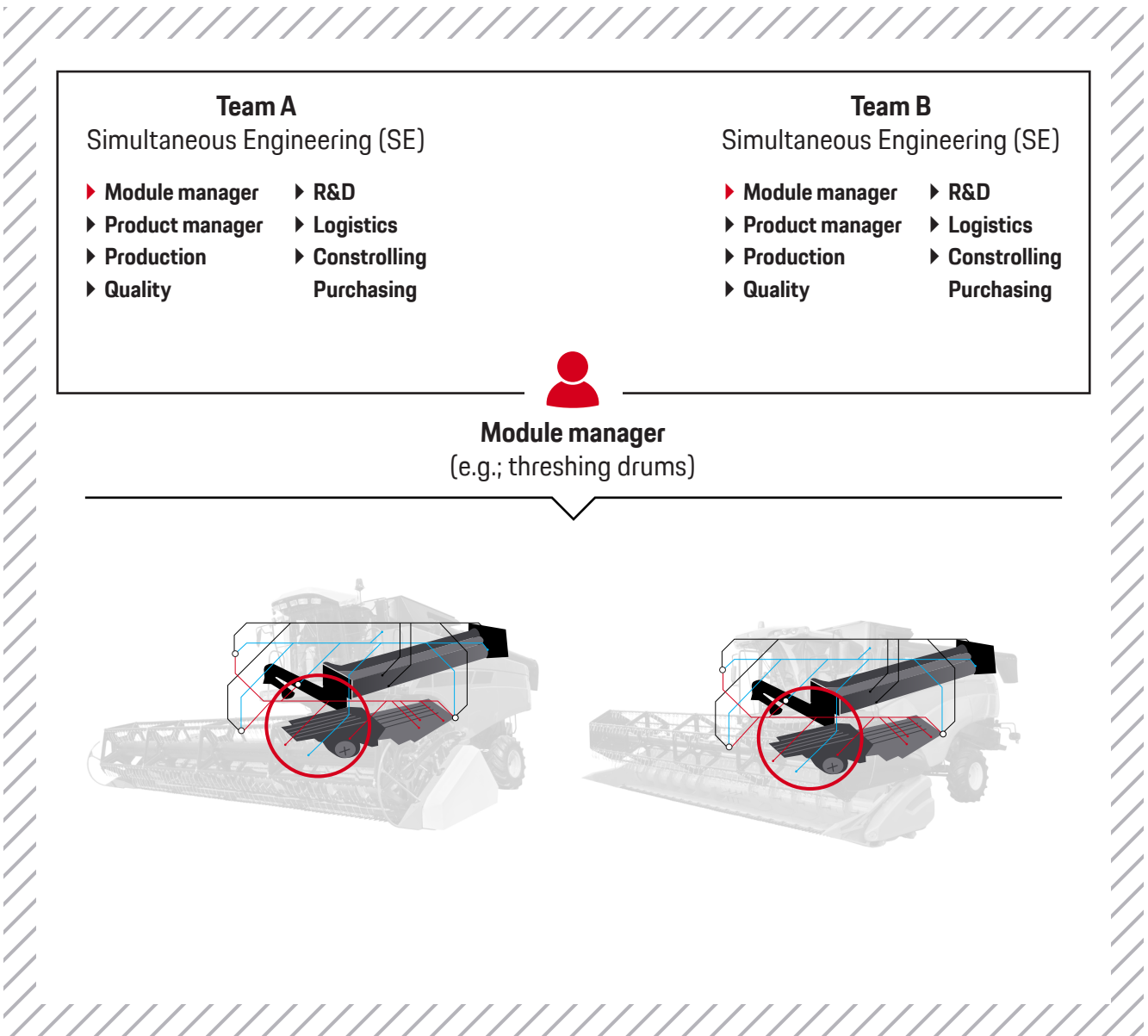
Fig. 8. Modularization example: wind turbine⁴

Possible modules

- 01 Rotor blade
- 03 Tower
- 05 Generator
- 02 Hub
- 04 Gearbox
- 06 Converter & Transformer



Modularization governance and financials applied at agricultural machinery manufacturer

Besides different clients from the industrial goods and services business, Porsche Consulting supported globally leading agricultural OEMs on their growth paths and along their modularization journey with designing a modularization governance model across several business units.



© Porsche Consulting

Fig. 9. Modularization using agricultural machinery as an example: module manager as governance key role



The new governance model consisting of processes, organizational structures, and a financial evaluation model foresees the use of modules across different product lines to best leverage benefits. Therefore, a modular manager role is key to consolidate all technical requirements for the modules based on the product strategy, and to manage the development of the modules itself while interfaces to other modules and parts are considered. The coordination of module usage by user products and the alignment with their engineering teams is another important task. Synergies between development

projects can be achieved through interdisciplinary collaboration between the lead input product and the follow-on product. This is why the module manager needs to be part of simultaneous engineering (SE) teams for all user products. A close alignment with controlling and product management ensures the achievement of both—optimized module costs and fulfillment of all customer requirements. This is how modularization benefits can be leveraged even in industries with lower production volumes.

Further industrial application of modularization in the construction industry

In addition to traditional companies in the industrial goods sector, construction companies can also benefit from standardization and modularization. The business model is characterized by the fact that all projects are designed, planned, and implemented individually for each customer. Modules that follow a geometric specification allow the construction products to be standardized. Due to the horizontal addition

and vertical stacking of modules, almost all building sizes and types can be configured by the customer. By adding design features that are constructed using conventional construction methods (e.g., facade, roofs, plinth design), all specific customer requirements towards product can be met. That means individualization for the customer coupled with reduction of complexity for the construction company.⁵

Product configurator as front end to improve sales and customer experience

The demand for individuality is particularly noticeable in current purchasing behavior in the industrial sector. Industrial goods such as agricultural machinery or wind turbines must perfectly match the customer's requirements. The complexity, taking into account all selectable options and all restrictions, makes it necessary to support the sales department and the customer during the sales process in choosing the right configuration.

The product configurator helps to sell products that are very diverse and consist of multiple components, properties, attributes, parameters, and values. The customer and the sales staff should always be able to quickly and easily create a suitable product without losing sight of the costs. Depending on the needs and assortment, each product configuration can be additionally enriched with product images, graphics, and

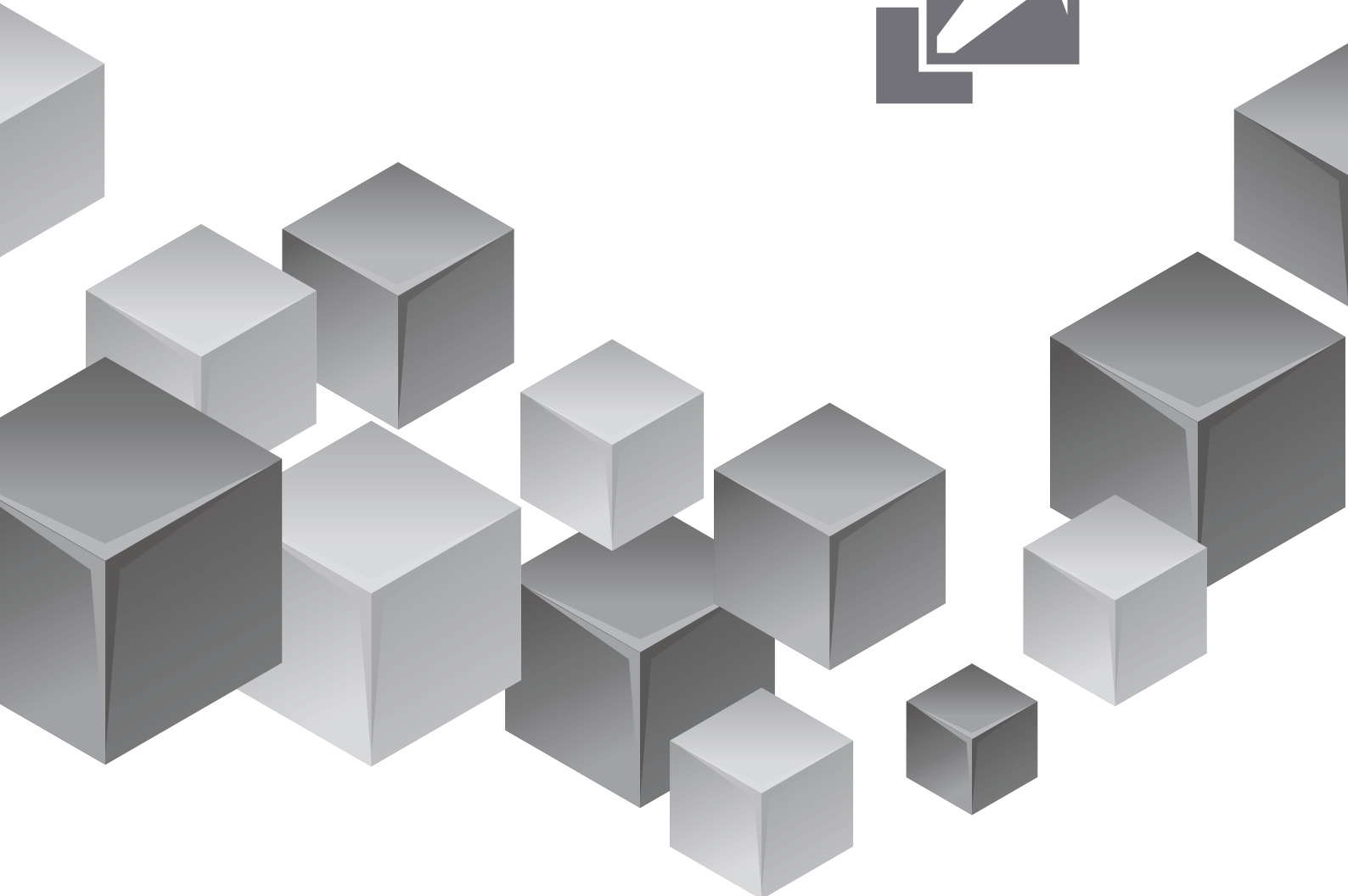
technical information points, so that the sale of the industrial product, which requires a lot of consultation, does not fail due to the complexity of the configuration. On the other hand, it is important that the large amounts of data that the configurator has to manage can be maintained with minimal effort.

Product configuration, variant configuration, and configuration software are the fundamental tools for a unique customer buying experience. In the area of product and variant configuration, configuration takes place both in the background, i.e., in the administrative back end, and at the front end, i.e., on the user or customer side. The configuration software is the basic framework for product and variant configuration. It enables the creation of basic configurations and the management of possible parameters through which a product object can be customized by the customer.

04

What you need to do

Implementing modularization and turning variants into modules begins by taking a clean-slate approach to designing a holistic vision and a basic product strategy. Our approach combines the implementation of modularization with the parallel achievement of quick wins for the rapid realization of cost savings and the anchoring of modularization in the organization.



Hybrid project approach for fast visible benefits

The modular journey begins with the product strategy, in which the future product portfolio, including the product life cycle, is defined on the basis of customer requirements. The modularization goal is defined with the module strategy; the use of modular kits in the current and future product portfolio is then determined. In the next step, the technical realization in the product portfolio is addressed. With the definition of a binding modular product architecture, modules can be defined that can also be used in the existing product portfolio in the short term.

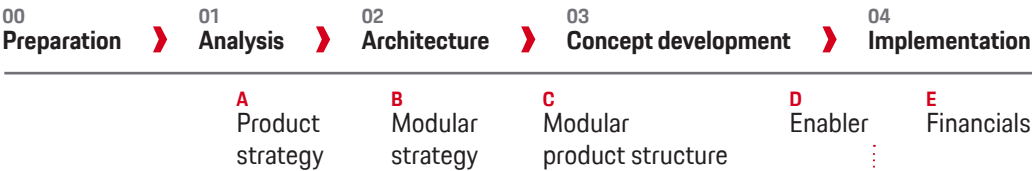
The hybrid approach enables the short-term realization of cost potentials in parallel. In Design-to-Cost sprints, modules that are used across different products are developed on short notice. This approach makes it possible to set the strategic direction of module management and at the same

time pragmatically implement modular management in the organization.

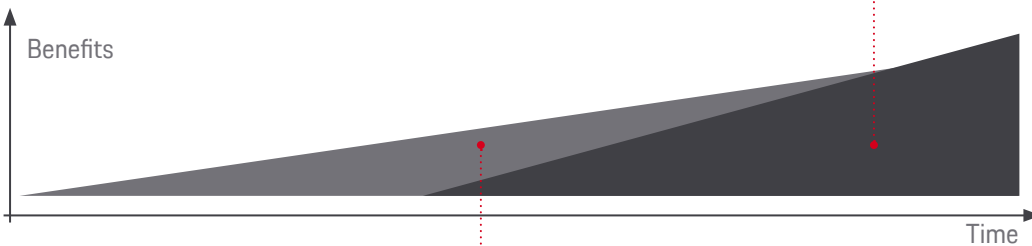
In addition, employees are trained in the methodical approach and the feasibility of the concept is demonstrated. In parallel, organizational framework conditions such as structural and process organization are created to institutionalize module management. This includes the definition of processes and governance structures as well as the establishment of a financial evaluation system.

The proposed project approach should be supported by intensive change management. For the operational project, teamwork principles and methods must be outlined in repeated training cycles as well as the resulting benefits.

Stream 1 | Modular journey



Change management and tracking (not included)



Results

- Cost reduction
- Market growth
- Innovation enabler

Stream 2 | Quick win

Use of existing modules and cost optimization/Design-to-Cost (DtC) sprints

Winning combination of short- and long-term benefits

- Cost reduction
- Competitiveness
- Qualification

© Porsche Consulting

Fig. 10. Modular journey project approach

With a hybrid project approach, the realization of modularization can be brought to life and the benefits made visible. The project team members can then act as a multiplier for the organization and communicate the purpose and benefits of modularization.



At the same time, the management team supports the change process by their example and acts as a role model. Strong commitment and fostering the use of modularization through action is a key factor that can then dispel potential reservations in the workforce and have a major impact on achieving the desired change in behavior. This process is supported by a dedicated communication plan.



05

How to get started?

The proposed process includes three main steps

01

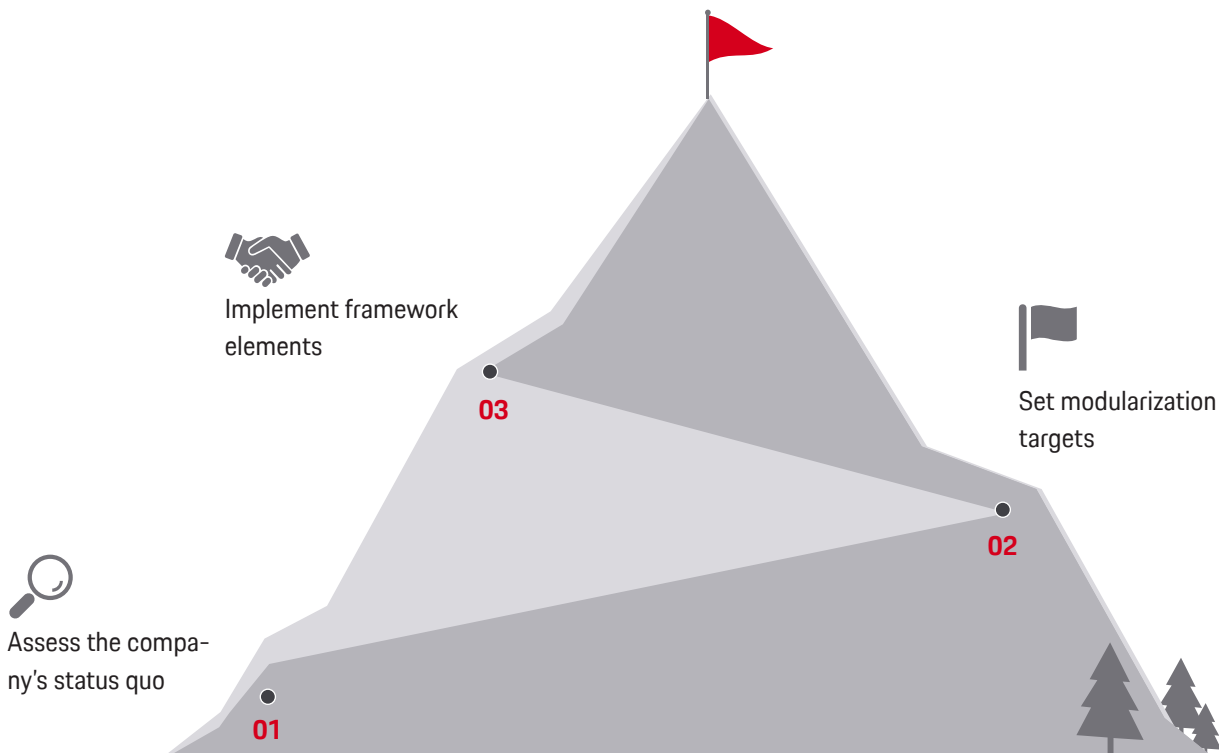
Assess the company's status quo. Understanding industry conditions and the competitive/customer environment provides the foundation for pursuing transformative change. An online assessment helps to identify key gaps.

02

Establish modularization goals. The company needs to settle on its strategic goals after weighing the expected level of standardization and flexibility to the customer. A clear financial goal with a positive payback of modularization efforts must be achieved.

03

Implement framework elements. All five elements of the framework are equally important and necessary for sustainable modularization. However, the right approach must be defined to strengthen existing solutions and implement missing aspects.



© Porsche Consulting

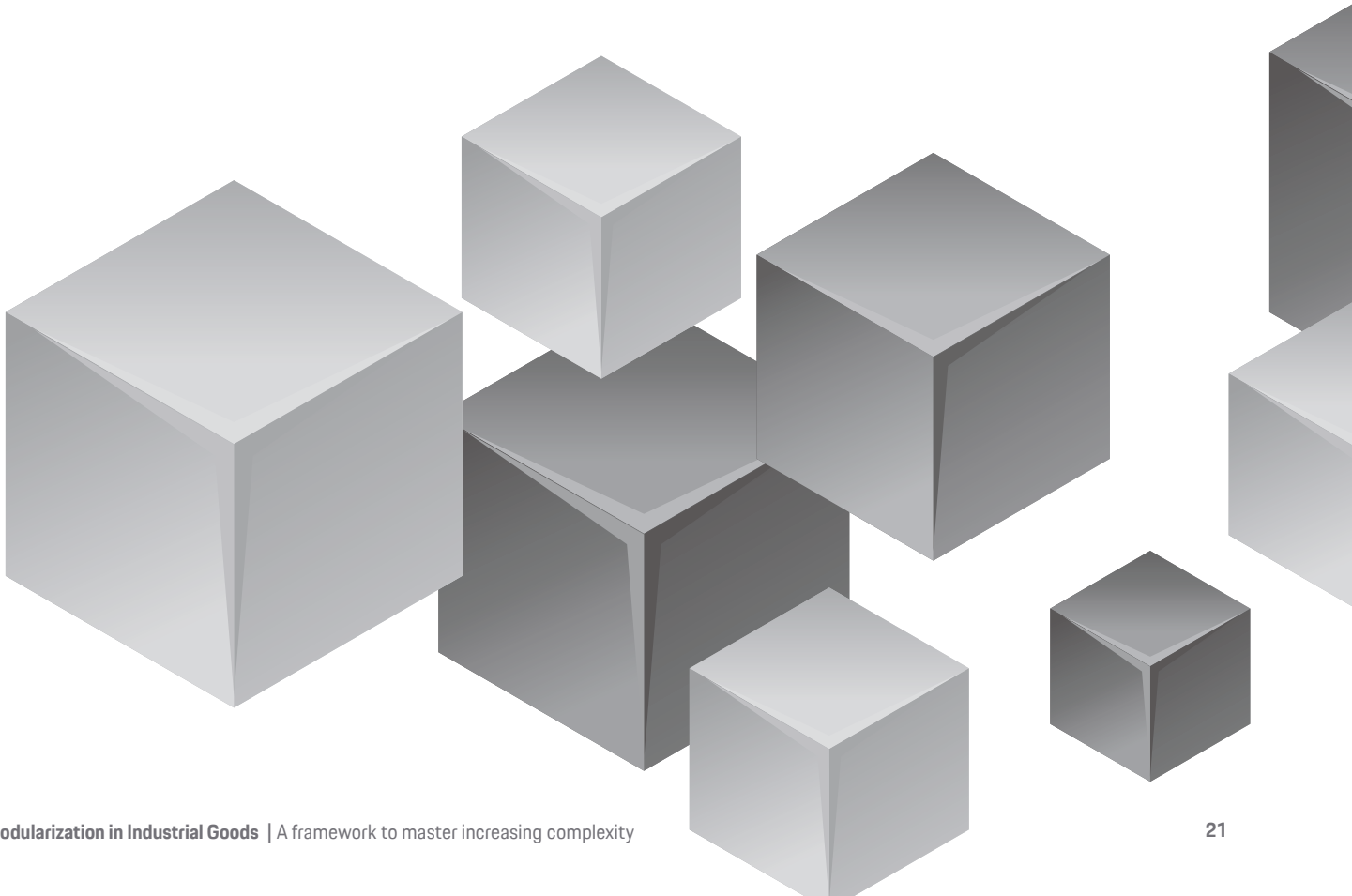
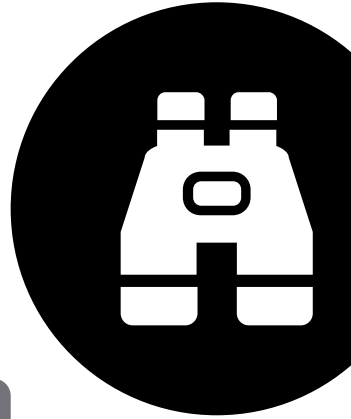
Fig. 11. Three steps to achieve a sustainable modularization

06

Summary and outlook

The implementation of modularization offers financial benefits, but also a positive competitive advantage through increased speed in order management. Technical implementation is a major challenge in product modularization. Another and often underestimated hurdle is the right setup of governance, processes, and methods.

Based on experience from many projects in the industrial goods sector, a holistic framework with five interlocking elements was developed. All five elements of the modular journey are essential and equally important for success. Implementing or optimizing modularization is a long road with significant benefits. The more consequently modules and modular kits are managed, the better the results will be.



Start your Self-Assessment

If you want to find out more about your current modularization maturity level, start the self-assessment and you will receive a free evaluation and comparison with the benchmark.

TRY IT OUT

01

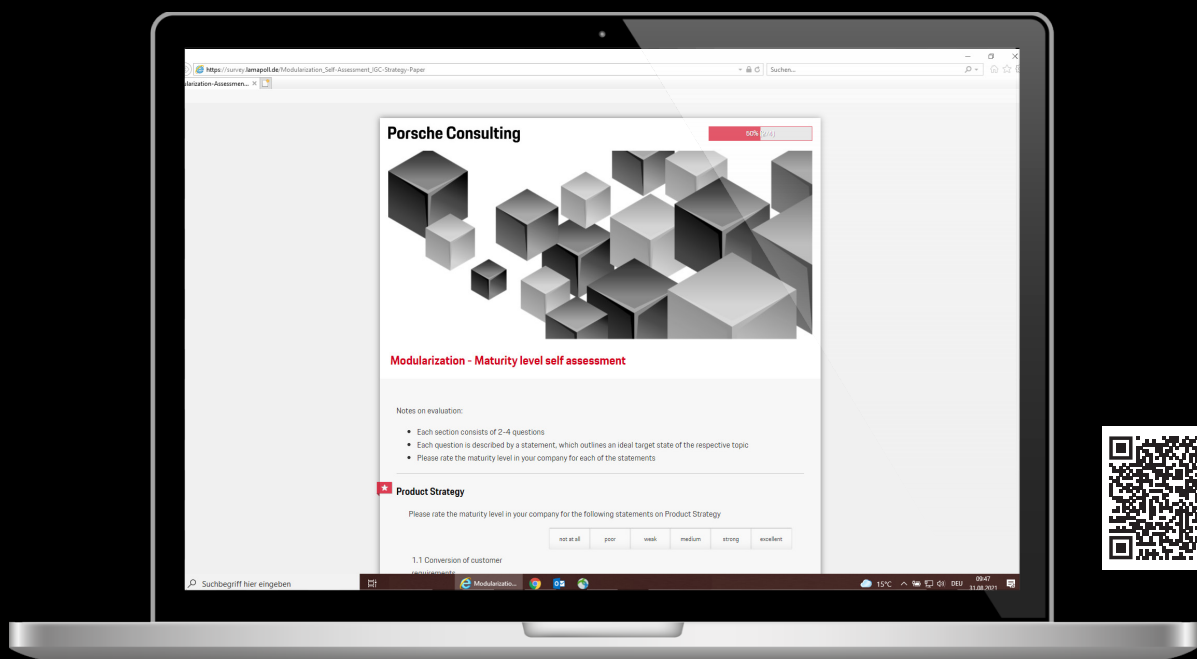
Follow the link [here](#)

02

Answer the questions

03

Get the evaluation by e-mail



Authors



Dirk Pfitzer

Lead Industrial Goods

+49 170 911-3376

dirk.pfitzer@porsche-consulting.com



Andreas Baier

Lead Speciality Vehicles



Stephan Ulbrich

Senior Manager



Christoph Remmers

Manager



Tobias Michels

Manager

Co-authors

The authors would like to thank Sebastian Lemm (Partner), Francesco Leoni (Associate Partner), Karl-Michael Acker (Senior Manager), Oliver Dolny (Senior Manager), Manuel Schönwitz (Senior Manager), Alberto Cassandro (Manager), Martin Bonev (Senior Expert) and Daniel Manz (Senior Consultant) who are co-authors of this paper.

Porsche Consulting

Porsche Consulting GmbH is a leading German strategy and operations consultancy and employs 685 people worldwide. The company is a subsidiary of the sports car manufacturer Dr. Ing. h.c. F. Porsche AG, Stuttgart. Porsche Consulting has offices in Stuttgart, Hamburg, Munich, Berlin, Frankfurt am Main, Milan, Paris, São Paulo, Shanghai, Beijing, Atlanta, and Palo Alto. Following the principle of "Strategic vision. Smart implementation," its consultants advise industry leaders on strategy, innovation, performance improvement, and sustainability. Porsche Consulting's network of 12 offices worldwide serves clients in the mobility, industrial goods and lifesciences, consumer goods, and financial services sector

Strategic Vision. Smart Implementation.

As a leading consultancy for putting strategies into practice, we have a clear mission: we generate competitive advantage on the basis of measurable results. We think strategically and act pragmatically. We always focus on people—out of principle. This is because success comes from working together with our clients and their employees. We can only reach our aim if we trigger enthusiasm for necessary changes in everyone involved.

Appendix

Sources

(01) See VDMA, "Leitfaden Industrie 4.0," http://industrie40.vdma.org/documents/4214230/5356229/VDMA_Leitfaden_I40.pdf

(02) Porsche Consulting survey "What are the biggest challenges in product modularization in your industry?", April 2021

(03) <https://www.maschinenmarkt.vogel.de/siemens-baut-windkraftanlagen-nach-plattformstrategie-a-394377>

(04) In accordance with <http://www.wind-energy-the-facts.org/architecture-of-a-modern-wind-turbine.html>

(05) <https://www.maxmodul.de/>

Link:

https://survey.lamapoll.de/Modularization_Self-Assessment_IGC-Strategy-Paper

Porsche Consulting

Stuttgart | Hamburg | Munich | Berlin | Frankfurt | Milan | Paris | São Paulo | Atlanta | Palo Alto | Shanghai | Beijing

www.porsche-consulting.com

© Porsche Consulting 2021