
Modular strategy and
complexity optimization

Platforming and modularity: smart answers to ever-increasing complexity

Common architecture, standard product portfolio elements, and a systematic approach can help companies cut costs and boost top-line growth.

Fabian Bannasch, Volker Grüntges, Giorgio Rossi, and Florian Weig

Effectively managing complexity has become essential to business success.Whereas in the past consumers were satisfied with a handful of choices in everything from automobiles to appliances, today few companies can survive with such a basic product portfolio. The shift has been dramatic: an automotive original equipment manufacturer (OEM) that once limited its offerings to 6 compact models now lists 17 different compact-class vehicles. The same phenomenon affects industries worldwide, and things are changing more quickly than ever. For example, the number of mobile phones offered by a major electronics company exploded from 5 models in 1990 to more than 180 in 2013, with a vast range of specifications, features, and geographic variants.

Within rapidly growing product portfolios, products themselves have also become more complicated, as companies offer more features to elicit an emotional response from consumers. Add the faster innovation cycles across global markets that complicate portfolios as well as more intricate aftermarket parts management issues, and complexity begins to seem overwhelming.

Using a new model to defeat complexity

While the challenge is significant, companies in a wide variety of industries can effectively manage complexity by modularizing product architectures and introducing specific platform and module strategies, as Exhibit 1 shows. Based on hundreds of modularity engagements and major product architecture transformations across industries from automotive to machinery, from aerospace to oil and gas, and from furniture to steel mills, McKinsey has developed a unique perspective on how to support companies looking to improve in this area. (For more on how industries with lower volumes in particular can benefit, see sidebar, *"Making platform and module strategies work in lower-volume industries."*) In designing common platform architectures, boosting product portfolio commonality, or mobilizing and reshaping organizations, teams must establish enduring improvements and embed modularity principles early on in new generations of products.

Platform and module strategies offer an array of potential benefits beyond the obvious material cost savings gained from increasing or bundling purchased volumes. Viewed in operational terms, benefits come from inventory reduction through standardizing parts and simplifying assembly processes, which can affect both labor hours and product quality. Companies achieve these goals by enabling greater stability and repeatability in manufacturing activities. One leading furniture manufacturer used these approaches to cut assembly and rework hours by roughly 30 percent. Firms typically capture significant one-off cost reductions by enforcing best-practice standards across the portfolio, thus replacing costly niche components with standardized ones. A leading industrial equipment manufacturer used this technique to replace more than 70 different hydraulic pumps with a new portfolio of 20 "plug and play"-like solutions.

Adopting platform and module strategies can reduce the number of product variants, enabling companies to capture R&D savings. Such strategies also help them increase the productivity of engineering resources, which can constrain growth for high-tech companies if left unaddressed. In fact, a global aerospace company reduced its engineering hours for the development of a new product by 30 percent using these methods.

Exhibit 1

Many industries can benefit from managing complexity through module and platform strategy

High-volume business	Low-volume business	Project business
Premium automotive original equipment manufacturer (OEM) ▪ Modular strategy across entire product portfolio ▪ **20% direct material cost reduction** ▪ **30% quality increase**	Furniture manufacturer ▪ Instrumental to switch from "island" to "line production" ▪ **10% direct material cost reduction** ▪ **30% cost reduction in assembly**	Steel plant manufacturer ▪ Identification of standard (70%) and differentiating modules ▪ **60% reduction of engineering hours** ▪ **20% reduction in time to market**
White goods manufacturer ▪ Cross-regional optimization of product lines ▪ **20% direct material cost reduction** ▪ **5 - 10% reduction in assembly time**	Industrial equipment OEM ▪ Global platform/module strategy in a multibrand setting ▪ **~ 75% of parts (by value) shared across regions** ▪ **7% improvement in earnings before interest and taxes**	Oil and gas equipment ▪ Fields' design philosophy reviewed in line with key supplier standards ▪ **~ 20% reduction in time for first oil** ▪ **15% reduction in capital expenditure**

Modularity can also be a powerful way to boost revenue growth. One multinational oil and gas player demonstrated this effect by modularizing the construction of deep-blue oil platforms, reducing the company's "time to first oil" by 25 percent and generating an extra USD 1 billion in revenues in the process.

Embracing the six pillars of modularity success

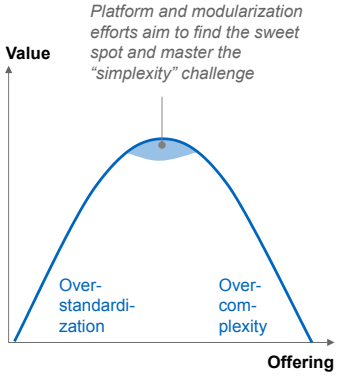
One question for companies starting to think about platforms and modules concerns the depth of commonality to seek—how much is enough? Not enough and they might miss the full potential and waste time and resources, while too much could erode brand and product appeal as well as sales. The answer lies beyond engineering alone, and achieving it requires teams to review and rethink their product strategies and collaborate with other functions (Exhibit 2).

Experience shows that effective players apply six success factors that together provide pillars of support for any global platform and module strategy.

Companies must find the right balance to successfully manage platform and module complexity Exhibit 2

Operations focus

- **How much commonality and differentiation is feasible** from a pure engineering perspective?
- How should I deal with necessary **technical trade-offs?**
- What **optimization levels below the part level** can we take advantage of (e.g., testing standards)?



Market focus

- What are our **product/ brand value propositions** and how can we best deliver against those?
- What is our **product positioning across regions?**
- What are **key customer buying factors?**

Plan ahead. Companies should have a long-term, forward-looking perspective on modular architectures instead of an opportunistic, one-off reuse of parts across products. They should fully integrate platform and module development into a broader product portfolio strategy and planning framework, setting clear milestones for important product events such as new launches or face-lifts over the entire product cycle. They should also interlink design, brand, platform, and innovation views. In this context, introducing a new modular feature in the product range itself will become a key innovation milestone. A leading automotive OEM recently demonstrated this by introducing new modular light-emitting-diode headlight solutions across its entire range of premium products.

Launch a comprehensive effort. Moving beyond standardization alone, it is important to employ a broader set of cross-functional modularity tools and techniques. Examples include introducing lifecycle decoupling (customer interfaces or controls versus electronics for car infotainment) or reviewing sourcing strategies with the procurement function to boost scale effects or break up supplier monopolies. In the automotive industry, one truck manufacturer established dual sourcing for a fuel injection system by standardizing the design specification. Likewise, a car OEM standardized the space for its seat control units, enabling teams to apply the latest equipment across all modules and thus capture a 30 percent cost reduction in three years.

Use a fact-based approach. Experience shows that it pays to overinvest up front to create data transparency so that teams can drive modularity decisions based on facts, not gut instinct. If data are unavailable or unclear at the start of a project, opinion-based discussions can easily prevail and lead to poor decisions, thus undermining the credibility of the effort. There are several typical questions at this point: how many different variants of a component does the company use today, and why do they exist? Which products use each component variant, and what are the specifications and costs associated with it? What drives current complexity levels?

In many cases, the answers are counterintuitive. Why? Companies usually base product decisions on past choices that over time can harden into unchallengeable mantras. For example, when interviewing aerospace customers, one company learned that few required independently moving blades for the wiping and washing systems of VIP aircraft. This insight enabled the company to achieve a 15 percent weight and cost reduction by eliminating one of the two motors used to move each blade separately. Moreover, baseline clarity is important because companies often find that it is not feasible to standardize an entire module. By digging deeper (if data are available), standardizing solutions at the component or interface levels can deliver surprising results.

Clearly differentiate offerings. This requires teams to develop an explicit understanding of the sources of product or regional distinctiveness, which they typically develop in collaboration with the marketing and sales function. Differentiating specific components to reflect a product's unique selling proposition requires companies to establish guidelines for future development. Teams need to ask which customer segments specific products should address, what specifications each product needs to fulfill, and what its unique selling propositions are.

Such differentiation has two main benefits. It can help teams define modularity boundaries and provide focus for the effort. Additionally, it enables development teams to collaborate more closely with the sales and marketing departments as they define what modularity means in the current situation and how the company should communicate the concept to end customers. An aircraft manufacturer quantified and effectively communicated to customers the advantages of having a single exchangeable seating structure across the entire fleet. In doing so, it preserved the "touch and feel" of the brand by keeping the same range of choices in preferred upholsteries, headrests, and other visible features. The underlying message to customers was "modularity enables us to offer you more, not less."

Systematically share knowledge. Experience demonstrates that the best companies codify knowledge early in their modularity journeys and formalize their decisions in comprehensive module books (Exhibit 3). These books summarize all the module's strategy elements, including baseline data, guidelines for standardizing parts and components, expected technological-evolution paths, sourcing strategies, and other information. Module books serve as binding guidelines for all future development projects; like any other company policy, they should include formal change management processes. Key stakeholders must sign off on these guidelines, including R&D, marketing and sales, manufacturing, quality, and purchasing—everyone who formally adheres to modular requirements for future projects.

Achieve sustainable impact. Building sustainability involves a number of different ingredients and, in the enthusiasm stirred by early modularity successes, companies often underestimate the effort required to make impact last. For example, making sure the company's IT infrastructure can codify and manage common part numbers on schedule is a must-have element of any plan to implement and measure modularity improvements. If not addressed in a timely manner, it can significantly slow down and endanger the program's success, hindering engineer's efforts to identify the correct common parts to use, for instance.

Exhibit 3

Use one common project definition per platform, incorporating platform- and product-specific content for all projects

From product-specific project definitions …

One project definition per product, locally developed for a specific project on a specific platform

A project approval milestone for each project is assigned per project and not linked to other projects in respective platforms

Individual project definitions are neither communicated nor aligned among products and thus hinder targeted product differentiation

… to project definition of a platform project

One definition per platform project, including platform and nonplatform content for all products on the platform

Developing **complete specifications for a project-approval milestone of a first-user project** requires early definition of cornerstones for follower projects

Communicating specifications to product groups and having them sign off ensures cross-product transparency and differentiation

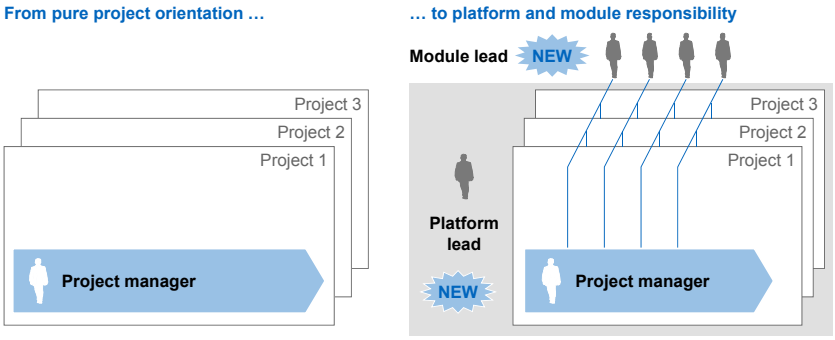
From an organizational point of view, mastering modularity will require a deep and complex transformation when it comes to roles, responsibilities, and product development practices (Exhibit 4). Consequently, companies cannot approach it as a one-off project. While there may not be a one-size-fits-all organizational model, companies can still identify a set of common elements that relate to the development and application of modular solutions across families of products and platforms, the coordination of innovation cycles in the company's broader portfolio strategy, and the need to monitor commonality and avoid a resurgence of complexity.

Companies typically address these requirements by appointing central module managers. An automotive OEM might assign a rear axle module leader, while a cell-phone OEM might hire a display technology champion. These managers coordinate the company-wide portfolio of variants, define specifications for common parts, and guard against complexity creeping into their systems. They also work closely with platform and project managers to ensure the best trade-offs are made between modularity and product-specific requirements.

In addition to the six pillars, top-management commitment is a precondition for success. Companies pursuing modularity must make their journey a broad, cross-functional effort that involves a significant mindset change and a systematic approach.

To make module strategies sustainable, new roles and processes are necessary

Exhibit 4



- Platform and module leads provide **continuity** of standards across projects
- Project manager feedback facilitates **continuous improvement**
- **Concurrency increases** as there is less need for interface alignment

The most successful efforts, especially for companies launching a modularity approach for the first time, involve company-wide assemblies where top managers openly discuss the opportunity to launch their program and the expected benefits and risks. These communication campaigns, especially when they involve a deeply committed CEO and top managers in program status reviews, help confirm the cross-functional nature of the effort and demonstrate what is required to sustain the change.

Launching an effective modular strategy

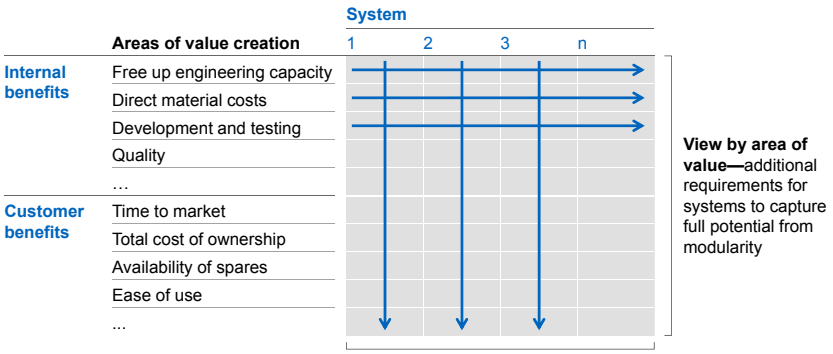
When deciding whether to launch a modularity program, companies typically struggle with three questions: Is this approach applicable to my industry and specific situation? What are the benefits for us and our customers? Where should we start?

To help leaders answer these questions, McKinsey developed a diagnostic that can quantitatively assess business opportunities from modularity in a few weeks (Exhibit 5). It encompasses internal dimensions, such as material costs, engineering hours, assembly complexity, and nonrecurring investments, as well as external dimensions, such as time to market, total cost of ownership, ease of use, and availability of spare parts.

The diagnostic includes a homogeneous rating logic framed across four cross-functional dimensions: the overall design architecture, the harmonization of subsystems, supply chain and sourcing integration, and manufacturing and assembly procedures (Exhibit 6). Next, the team translates the identified modularity gap into quantitative impact through cross-functional workshops and defined algorithms. The stakeholders then agree on how to prioritize interventions, balancing impact, the effort required for implementation, and the strategic relevance of the systems under review.

The cross-functional nature of the assessment provides several benefits. First, it allows companies to engage in a fact-based discussion on rethinking products in a modular way. The assessment also creates alignment across all functions regarding objectives and targets, eliminating the perception of conflicts between the external and internal impact of modularity. Additionally, it shows the importance of cross-functional collaboration in driving the success of the initiative. Finally, it helps companies to prioritize their interventions so that they focus on the most promising and rewarding product families or platforms.

Exhibit 5 **A modularity diagnostic helps companies gauge their starting point**



Alternatively, if it is relatively clear from the outset which modules would be the best to test the methodology (for example, given their expected benefits-to-effort ratio or their technological relevance), companies may prefer to start with a pilot effort focused on a limited set of priority modules, seeking "proof by action."

In this way, they can use concrete examples to answer critical questions and make trade-offs that typically arise in the first steps of the modularity journey, such as striking the right balance between standardization and customer differentiation (through focused customer insights and structured, analytical identification of sources of distinctiveness by product) or between standardization and cost differentiation (through the definition of different technical specifications and a clear-cut target costing approach).

In order to trigger these discussions at the start of the process and at the right level of depth, we often suggest limiting the scope of such pilot projects to two or three diverse modules. For instance, we typically include highly technical modules, such as a portfolio of hydraulic components with potential conflicts related to technical feasibility, interfaces, and cost differentiation as well as customer-facing modules, like user-interface components, which can help stimulate discussions on product differentiation, customer value, and innovation cycles.

To assess the commonality of systems, companies should use a homogeneous rating logic

Exhibit 6

Level 1 description	Assessment dimensions	Level 4 description
▪ **No common architecture** ▪ Philosophy, **performance requirements, and technology differ** for each product	Overall design architecture	▪ **Single design architecture** for the full range of products ▪ **Functional specifications** defined and **fully covered** by the common architecture
▪ **Subsystems designed** for each product ▪ **Different materials and standards** (e.g., no components catalog)	Harmonization of subsystems	▪ **More than 70% of subsystems modularized** across products ▪ **Materials harmonized** ▪ **90% or more of standard fasteners/fittings**
▪ **Suppliers selected on a case-by-case basis** given specific opportunities ▪ No control on **tier-2 suppliers**	Supply chain/ sourcing integration	▪ **Strategic suppliers identified and engaged in modularization efforts** ▪ Limited list **of tier-2 suppliers agreed to** ▪ **Frame contract in place,** with clear benefit (e.g., synergies for investments, spares)
▪ **Different tooling/manufacturing** approach ▪ In assembly, **few or no synergies** among **standard operating procedures** for different products	Manufacturing and assembly procedures	▪ **Unique set of tools/machines for > 40%** of systems, others designed through a modular approach (e.g., parametric) ▪ In assembly, **strong synergies (> 70%)** among **standard operating procedures** across product portfolio

Companies that are more advanced in their modularity journey, especially in the automotive sector (and those that have already experienced breakthrough benefits from platform and modular strategy), are evolving towards the concept of "modular architectures" to capture the positive scale effects of platforms and to allow an easier differentiation for customers if needed. These companies seek to design a more holistic transformational approach, often embracing the entire product portfolio and requiring a deeper contribution from all functions.

To sustain a broader transformation, it is important to assess the organizational implications early on to support the new way of working, especially with regard to the product governance model, product cycle planning, and interfaces between functions. While this approach requires a focused effort across large parts of the organization, it significantly reduces the risk of an incomplete transformation that ultimately results in a regression to the original state.

In such contexts, special attention should be also dedicated to the development of an integrated development cycle plan that describes the sequence of new product development projects, their launch dates on a clear timeline that underlies the development of modules, components, and innovative technologies. Using this tool, the organization can define its innovation road maps at the module level and achieve breakthrough results in component commonality; moreover, teams can simultaneously design the products derived from each platform to achieve a much deeper degree of commonality.

The experiences of these more mature companies help others to see that, contrary to common belief, modularity does not limit innovation. Indeed, they demonstrate that modularity can support innovation in several ways:

- First, by reducing the engineering effort required for the "easy" parts of a project, standardization allows technical staff to devote more time and attention to solving challenging problems and finding new ways to boost performance.

- Second, by ensuring that companies can reuse innovative designs across projects, modularity can accelerate the return on investment in innovative technologies.

- Third, standard modular architectures and interfaces between modules can make it easier for engineers to develop incremental improvements to individual modules without requiring costly rework elsewhere in the project design.

- Finally, significant time-to-market reductions enable companies to bundle R&D resources using true innovation road maps instead of reengineering several variants of a similar solution. They also help teams to improve the business cases for additional product variants.

* * *

The adoption of module and platform strategies can head off complexity and deliver substantial product-based competitive advantages (for both the top and bottom line), but companies must attack this challenge systematically. A scatter-shot approach rarely delivers the expected value and can multiply risks, in some cases endangering the market positioning of products themselves. By methodically understanding this unique opportunity to rethink their product portfolio, road map, and processes, and by addressing it as a strategic, cross-functional effort, companies can better navigate the crucial path to market competitiveness.

Fabian Bannasch is an Expert in McKinsey's Munich office, where Volker Grüntges and Florian Weig are directors, and Giorgio Rossi is a principal in the Rome office.