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The Lean Advantage in Engineering

Developing Better Products Faster and More Efficiently

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Developing Better Products Faster and More Efficiently

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AT A GLANCE

Companies in the forefront of applying lean methods in engineering are capturing a tangible competitive edge: developing better products, reducing development times by up to six months, and staying 35 percent closer to product target costs. These insights have emerged from BCG's project experience and a benchmarking study of 100 leading companies in the automotive and engineered-product industries.

Gauging Performance in Four Dimensions

The study assessed participants' qualitative performance in capabilities that drive effectiveness and efficiency in four dimensions: the product itself, development processes, leadership and behavior, and enablement and tools. It also benchmarked participants, comparing them with their top-performing peers in terms of, for example, the duration of engineering projects, share of projects completed on time and within budget, and share of products with fundamental changes to requirements after development starts.

Capturing a Competitive Edge

We have identified critical success factors in lean engineering—such as modularized product design and agile, fast-cycle processes—that give lean champions a measurable advantage over their competitors.

Companies in the automotive and engineered-product industries face complex and costly product-development challenges. Last-minute changes and time and cost overruns are common and, in many cases, attributable to poor alignment of product requirements, the development project's time line, and the product's target cost. Some products move forward in the development process despite obvious deficiencies because internal politics frequently trump objective facts. These problems typically stem from inadequate collaboration within and among departments, as well as a failure to capture, utilize, and share knowledge throughout the organization.

Today's market environment has intensified these challenges: product lines are proliferating, customers are ever-more demanding, and digitization is changing the way companies operate. To overcome these challenges and remain competitive in this dynamic market, companies need a new approach to product development that simultaneously improves quality, enhances speed, and controls costs. As Martin Winterkorn, CEO of Volkswagen, put it recently, "It's no longer all about bigger, higher, further. Now, it's about being leaner, faster, more efficient."[1]

Companies need a new approach to product development that simultaneously improves quality, enhances speed, and controls costs.

To address this imperative, many companies have started to explore the opportunities lean engineering offers: they are adapting lean methods that are used in production and administration and applying them to product development. The companies that were first to master lean engineering have gained significant competitive advantages by developing higher-quality products in up to six months less time, while reducing deviations from product target costs by more than 35 percent.

Although the benefits of lean engineering are clear, capturing them has proved difficult for many companies. The tried-and-true lean methods applied in production and administration do not correspond neatly to product development, in which processes are not easily analyzed and sequenced and waste is not clearly visible. Unlike traditional target areas for lean, the finished product is unknown at the beginning of the product development process.

Whereas production and administration entail consecutive processes, engineering requires creative loops within processes. This means that the process itself influences the final product specifications because the knowledge acquired leads to improvements. Moreover, deviations from a planned process—*muda* in lean terminology—are undesirable and costly on the shop floor or in the back office; however, in product development, deviations can provide valuable insights.

To what extent are companies applying lean methods in engineering and what are the success factors for creating value through these efforts? To find the answers, we have combined insights from our experience supporting lean transformations and a recent benchmarking study of 100 leading companies in the automotive and engineered-product industries. Our research partner in the study was the Department of Innovation Management of the Laboratory for Machine Tools and Production Engineering at RWTH Aachen University.

Our conclusions: Companies experience critical gaps between their aspirations for lean engineering and their current performance. To close these gaps, they need to take a broader and deeper approach to transforming the effectiveness and efficiency of their product-development function.

Driving Effectiveness and Efficiency in Four Dimensions

Like traditional lean approaches, lean engineering targets eight types of waste in the product development process. However, the engineering environment has several distinctive characteristics that differentiate it from production and administration—most important, the uncertainty of its output—and this environment therefore has its own sources of waste and non-value-adding activities. (See Exhibit 1.)

A company's objective in seeking to eliminate waste through lean engineering should not be to create a fully predictable streamlined process. This is an unattainable goal. Instead, the objective should extend beyond mere cost cutting to include

EXHIBIT 1 | Lean Engineering Targets Eight Types of Waste

Types of waste		Engineering examples
Overproduction	Producing information or products that are not needed	• Decisions to terminate projects made too late ("riding dead horses") • Redundant parallel development processes (lack of communication)
Overprocessing	Producing more information or products than are needed	• Product overengineering (unnecessary features) • Insufficient utilization of expertise (reinventing the wheel)
Motion	Movement that is not producing value	• Frequent searching for information • Information pushed to the wrong people (excessive e-mail copying)
Transportation	Non-value-adding movement of information or products	• Too many development-process handoffs • Software incompatibility leading to manual information sharing
Inventory	Collection of information that is not yet formally processed	• Half-finished features (works in progress) • Team members using their own information-management or filing systems
Defects	Results of executed processes that do not produce value	• Erroneous calculations or data input • Measurement errors (due, for example, to the wrong testing methodology)
Waiting	Non-value-adding waiting times	• Waiting time during handoffs; cases of incomplete information • Time spent getting multiple approvals
Unused resources or talent	Underutilized intelligence or creativity	• Highly skilled staff performing repetitive work (data input) • Premature freezing of design, curtailing creativity and innovation

Source: Lean engineering benchmarking study, Laboratory for Machine Tools and Production Engineering, RWTH Aachen University, and BCG.

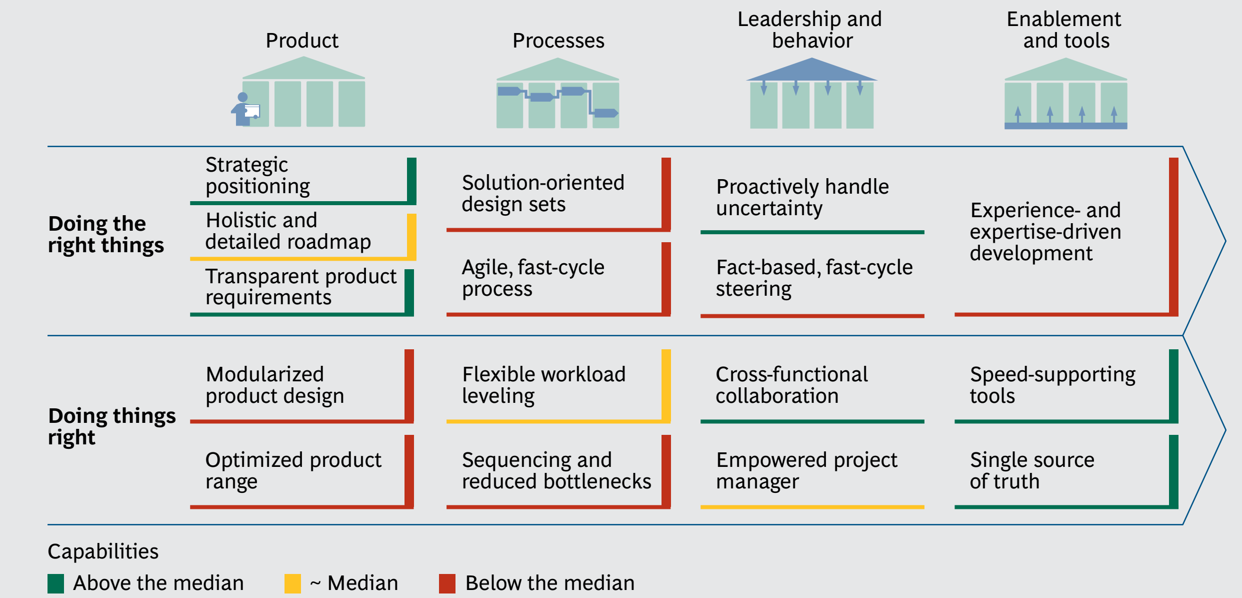
improvements in quality and time, as well as in customer and employee satisfaction. The company should also look beyond quick wins and pursue improvements that can be sustained over the long term. Success requires both bottom-up solutions created by product development teams and top-down solutions developed higher in the organization.

Furthermore, companies need to consider and adapt complementary techniques beyond the scope of traditional lean. Our analysis shows that automotive and engineered-product companies can successfully apply the "agile" methodology widely used by product development teams in software and IT industries. Agile uses fast, iterative development cycles over the course of the project. The objective is to develop a viable product—often referred to as a "minimum viable product"—quickly and then to improve it through reiteration. This objective contrasts with that of traditional development approaches, which aim to define comprehensive and detailed specifications up front in an effort to yield the "perfect" product.

To master lean engineering, a company needs capabilities that drive effectiveness (doing the right things) and efficiency (doing things right). Through our work supporting companies in lean transformations of their engineering functions, we have identified 16 capabilities in four dimensions that are crucial for success: the product itself, development processes, leadership and behavior, and enablement and tools. (See Exhibit 2.)

Product. Enhancing the product's effectiveness begins with the definition of a forward-looking process aimed at determining the product's *strategic positioning.* For example, will it be a premium or a low-cost product? This positioning sets the boundaries within which innovation and development activities for the product can

EXHIBIT 2 | Lean Engineering Entails 16 Capabilities in Four Dimensions



Source: Lean engineering benchmarking study, Laboratory for Machine Tools and Production Engineering, RWTH Aachen University, and BCG.

occur. In this context, the development team should systematically identify and plan technologies, products, and modules on the basis of a regularly updated *holistic and detailed roadmap* that spans at least five years. Early in the project, the team must also translate customer requirements into a full set of *transparent product requirements* that make interdependencies fully visible.

Efficiency is driven by fully utilizing modularized product design across all product lines.

Efficiency is driven by fully utilizing *modularized product design* across all product lines. A high utilization rate for carryover parts (that is, parts that are common to successive generations of products and multiple product lines) needs to be enforced through a structured process with clear top-down targets. To determine the *optimized product range*, the company must also employ a structured process to rigorously evaluate the benefits and complexity costs of all additional product variants.

Processes. To improve the effectiveness of processes, companies should simultaneously develop alternative *solution-oriented design sets* at the beginning of the project. The company should implement and follow a stringent funnel process to systematically reduce the number of alternative designs under development. An *agile, fast-cycle process* should be used to ensure continual creation and fast recalibration through short cycles and iterative feedback loops.

Flexible workload leveling, based on a well-designed launch plan and regular capacity reviews, is essential for process efficiency. To reduce bottlenecks during the project, the plan should define actions aimed at mitigating foreseeable capacity-utilization issues. Examples of such actions include giving the staff advance training so that they will be prepared to handle the new responsibilities that arise at each stage of the process and outsourcing selected process steps. Efficiency also requires *sequencing and reduced bottlenecks*. By modularizing and standardizing all processes into sequences with clear output, the company can identify bottlenecks early on and remove them.

Leadership and Behavior. To reduce errors in the development process, companies need to *proactively handle uncertainty*. They can do this by, for example, ensuring that decisions are based on objective criteria and by promoting a mind-set that understands that failures can be learning opportunities. Furthermore, they should define a targeted set of meaningful KPIs that support the *fact-based, fast-cycle steering* of projects.

Efficiency is driven by *cross-functional collaboration*. Companies need to systematically integrate dedicated representatives from all affected functions—including sales and marketing, manufacturing, quality, supply chain, and after-sales—into the engineering process. A formalized process for sharing information should support this collaboration. Companies should also ensure that one *empowered project manager* is responsible for all aspects of the project's success, from concept to the start of production.

Enablement and Tools. *Experience- and expertise-driven development* is essential for promoting effectiveness. Companies can maximize reuse of the solutions they develop and the lessons they learn by creating and regularly updating an easily accessible knowledge-management system, such as a design library.

To promote efficiency, companies need *speed-supporting tools*—for example, rapid prototyping, 3-D printing, and digital engineering—that allow teams to quickly model and test designs. A *single source of truth* for product data is also essential. This central product-data repository should be managed using a consistent, integrated framework throughout the product life cycle.

Benchmarking Lean Engineering Today

Our study assessed the current status of companies' efforts to apply lean methods to engineering, benchmarked participating companies against their top-performing peers, and identified success factors. Respondents included managers and executives at automotive OEMs (7 percent), automotive suppliers (17 percent), machinery manufacturers (32 percent), and component manufacturers (32 percent), as well as other industrial-goods companies, such as construction companies (12 percent). Participating companies are headquartered in Europe, the U.S., and Asia, and range from midsize companies to large, multinational enterprises. The survey, which included Web and print questionnaires, was supplemented by interviews with selected participants. (See the sidebar, "Our Qualitative and Quantitative Assessment.")

Gauging Performance in the Four Dimensions

Our results reveal that most participating companies have at least considered implementing lean methods in engineering. Most of these companies, however, are still at the beginning of this process. (See Exhibit 3.) Automotive OEMs and machinery manufacturers are the frontrunners. Nearly 30 percent of automotive OEMs and 35 percent of machinery manufacturers regularly use lean methods in engineering, compared with approximately 5 percent of automotive suppliers and approximately 15 percent of component manufacturers.

Most participating companies have at least considered implementing lean methods in engineering. Most of these companies, however, are still at the beginning of this process.

Across industries, our qualitative assessment found that participating companies perform well in some of the 16 lean-engineering capabilities, but there is a clear need for action to improve performance in all four dimensions described above. Exhibit 2 shows how participating companies perform in each of the 16 capabilities relative to the overall median performance across all capabilities. The results reveal areas of strength as well as opportunities for improvement.

On a positive note, we found high levels of maturity in several capabilities. For example, most participating companies already diligently translate customer requirements into a full set of product specifications, and their development teams include representatives from most other functions quite early in the process.

However, the assessment also identified significant improvement opportunities for capabilities within each dimension.

- In many companies, modular product systems are used in only a few product lines. New products are developed with limited reutilization of existing modules.
- The engineering process is typically broken down into five or fewer long phases, some lasting six months or more, with feedback provided at intermediate stages.

OUR QUALITATIVE AND QUANTITATIVE ASSESSMENT

The survey questions allowed us to qualitatively and quantitatively assess the importance and status of each of the 16 lean-engineering capabilities in the four dimensions—the product itself, development processes, leadership and behavior, and enablement and tools. Examples of these capabilities include the following:

- *Modularized Product Design.* Are modular product systems maximally utilized in new-product development?
- *Solution-Oriented Design Sets.* Are solution alternatives developed in parallel and systematically reduced?
- *Agile, Fast-Cycle Process.* Do short cycles and iterative feedback loops enable a fast recalibration?

For each capability, we based the qualitative assessment on an audit of what we term the four stages of excellence. These range from the lowest to the highest maturity level. Instead of simply choosing a numerical value to rate their company's maturity with respect to a capability, for each capability, respondents selected one of four clearly defined characteristics that best described its level of maturity. For modularized product design, for example, the four characteristics—from the lowest to the highest maturity level—were the following:

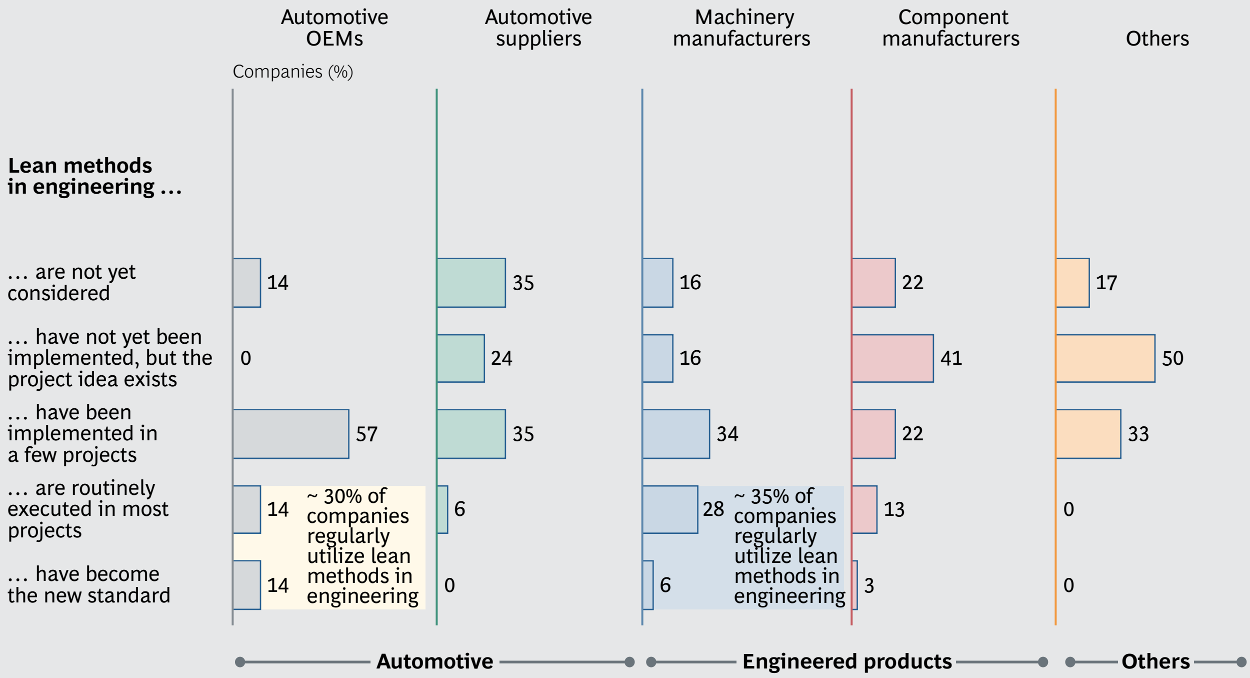
1. No modularization across product lines
2. Modularization of a few products; limited reutilization of existing modules
3. Modularization of the majority of product lines; high reutilization; no clearly identified top-down target
4. Modularization across all product lines; high reutilization; clearly identified top-down targets

We based the quantitative evaluation on an extensive, state-of-the-art benchmarking database comprising key metrics, such as utilization of carryover parts, capacity utilization, length of the development project, percentage of projects completed on time and within budget, and deviation from product target costs.

However, such phases are too long to allow for significant changes to a product that has progressed far into the development process.

- Engineering-specific KPIs—such as person hours or budget—are usually available but are not clear and meaningful enough to enable stringent, fact-based project steering. Design reviews occur too late in the process to allow for effective steering.
- Most companies do not have a cross-functional knowledge-management system, such as a design library. Instead, know-how is managed locally, and lessons learned are shared almost exclusively within a function.

Exhibit 3 | Many Companies Have Considered Lean Engineering, but Few Apply It Routinely



Source: Lean engineering benchmarking study, Laboratory for Machine Tools and Production Engineering, RWTH Aachen University, and BCG.
Note: Because of rounding, not all percentages add up to 100.

What Sets the Lean Champions Apart?

We identified lean-engineering "champions" and "followers" among participating companies on the basis of the degree to which they utilize lean methods in product development. Lean champions (19 percent) routinely apply lean methods in most projects, or they have established lean methods as the new standard in engineering. Lean followers (81 percent of respondents) have not yet considered lean methods in engineering, or they have implemented lean methods in only a few engineering projects.

The survey found that lean champions succeed in decreasing development time significantly. For example, among machinery manufacturers, lean champions were able to accelerate their product-development process, moving as much as 25 percent faster, on average, than lean followers—which means that lean champions are developing products up to six months faster.

Furthermore, lean champions have significant advantages in meeting the time and budget constraints of development projects. Lean champions, on average, complete 71 percent of projects within the scheduled time frame and 74 percent of projects within budget. In contrast, lean followers complete only 49 percent of projects on time and 56 percent within budget.

As these performance advantages would suggest, lean champions are more advanced in implementing lean-engineering capabilities in each of the four dimensions. The discrepancy between champions and followers is especially evident in two capabilities:

- *Flexible Workload Leveling.* Two-thirds of lean followers indicated that they have insufficient transparency with respect to actual-versus-planned capacity utilization and that they allocate work on the basis of urgent or short-term needs, leading to delays and extra costs. In contrast, two-thirds of lean champions indicated that they have full transparency into capacity utilization and that they specify flexible mitigation actions to avoid project disruptions in the medium and long term.

- *Experience- and Expertise-Driven Development.* Three-quarters of lean followers either do not have a system in place to manage know-how and best practices within the organization or share lessons learned only within their own teams. In contrast, more than 70 percent of lean champions employ a cross-functional knowledge-management system to maximize their reuse of developed solutions—in some cases on a global scale.

More than 70 percent of lean champions employ a cross-functional knowledge-management system to maximize their reuse of developed solutions.

Analysis of correlations between companies' performance and their execution of lean-engineering capabilities allowed us to identify success factors that set apart the lean champions in each of the four dimensions. The following in-depth discussions of two capabilities—modularized product design and agile, fast-cycle process—illustrate the opportunities for improvement and the success factors for superior performance. For each of these capabilities, we saw considerable differences between companies that applied the capabilities and those that did not. The impact on KPIs—such as the duration of the development process, the share of projects completed within time and budget, and the number of changes to product specifications after development begins—was noteworthy.

True Modularization Lags Behind Despite Ongoing Emphasis

Modularization of product architecture, platforms, and components has been on the automotive industry's agenda for decades. Companies that capture product functionality in distinct modules and reuse them across products can reduce costs, improve quality, increase the number of potential products offered, and accelerate the speed of development. Conversations with automotive executives suggest that modularization is a very prominent topic and is widely implemented within their companies. But our study reveals a gap between executives' emphasis on modularization and their companies' actual deployment of modular systems.

We found that the "true" degree of modularization—measured by the share of products built from a modular system—is less than 40 percent in the automotive industry. (See Exhibit 4.) Furthermore, the ratio of carryover parts to all parts is surprisingly low: the median is 30 percent for automotive OEMs and only 15 percent for automotive suppliers. In line with this, we found that automotive companies have generally not set clear top-down targets regarding the use of carryover parts.

Machinery manufacturers have leaped ahead of automotive OEMs and suppliers in implementing modularization across most of their product lines. When we asked these manufacturers what share of products they build using a modular system, the median response was 60 percent. Their high reutilization of existing modules results in a median carryover-part ratio of 30 percent.

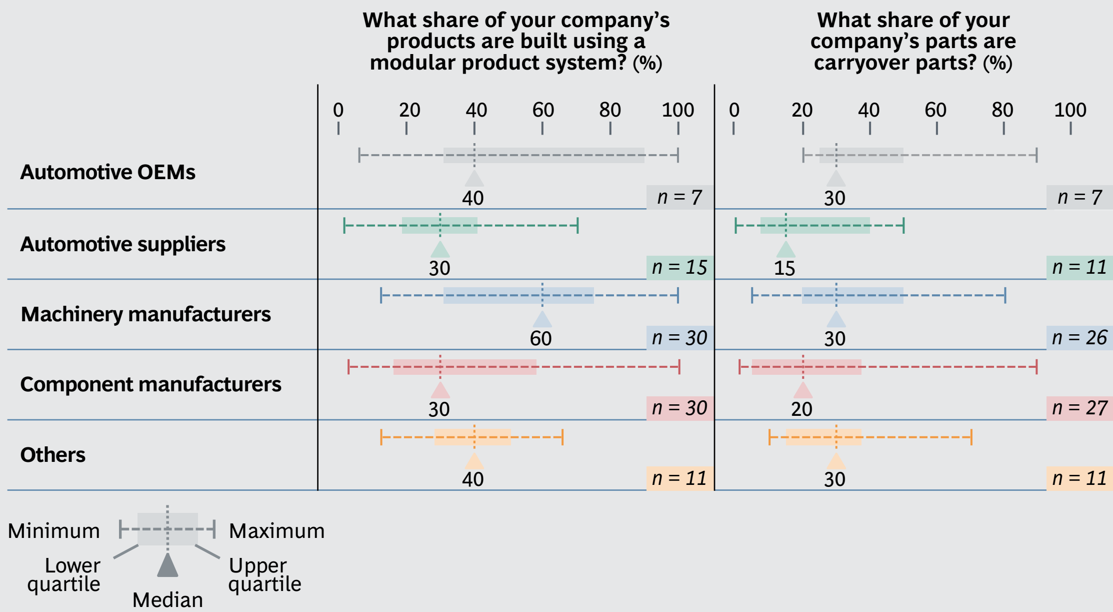
Most machinery manufacturers employ modularization, but the best performers in this capability go one step further: they maximize reutilization and synergies by creating optimal combinations and permutations of modules. This allows them to utilize carryover parts not only within product groups but also among product lines and families.

The study shows that the leaders in modularization (companies utilizing modularization across most or all product lines) are better at shortening the duration of the development process and improving planning accuracy than the laggards (companies that do not employ modular product systems or that reuse existing modules only to a limited degree).

- The leaders in modularization take approximately 15 to 20 percent less time than the laggards to complete development projects. This is especially true among engineered-product companies.

- On average, leaders in modularization perform significantly better in KPIs related to planning accuracy than do the laggards. The leaders complete 59 percent of their projects within the planned time frame, while the laggards complete only 45 percent of their projects on time. Similarly, the leaders complete 60 percent of their projects within the planned budget, whereas the laggards complete 56 percent of their projects within budget.

Exhibit 4 | Auto Suppliers and Component Makers Lag Behind in Modularization



Source: Lean engineering benchmarking study, Laboratory for Machine Tools and Production Engineering, RWTH Aachen University, and BCG.

These study results are in line with BCG's project experience supporting companies in achieving a significant, measurable competitive edge. For example, a large European machinery manufacturer sold mainly customized products designed to meet individual customers' detailed specifications. This emphasis on customization resulted in a highly complex product portfolio. While maintaining its business model of providing customized solutions, the company developed approaches to modularize its product designs, particularly for the most basic parts or components. Integrating modularization into its customized approach allowed the company to achieve a double-digit reduction of total life-cycle costs across the entire value chain—from engineering and procurement to manufacturing and quality assurance.

Short cycles and iterative feedback loops enable fast recalibration and continual course correction at all stages of the development process.

The top-performing companies do more than use a modular product system with standardized interfaces across the full range of product lines and families. They also differentiate modular product design on the basis of customer requirements. For example, even if they face constraints applying modularization to high-end products, they fully utilize modularization across low-end product lines. Additionally, they enforce the reutilization of carryover parts through a structured process with clear top-down targets, such as by requiring development teams to meet a specific carryover-part ratio.

Use of Agile Shows Room for Improvement

Traditionally, engineering was perceived as a continual process aimed at executing a single large and complex task. Consequently, it was not unusual for companies to fall into the trap of spending time and money developing products that did not meet customer needs. By employing a "fail fast" mentality in short cycles, the agile methodology enables teams to learn quickly from any missteps and apply the lessons to ensure that the development process stays on a path toward the "right" product for the market. Short cycles and iterative feedback loops enable fast recalibration and continual course correction at all stages of the development process. Teams employ a divide-and-conquer mind-set, splitting tasks into deliverables that are manageably produced within a short time frame.

Companies need to pursue the right priorities to capture agile's benefits in terms of quality, productivity, cost, and customer satisfaction. To foster creativity, individuals and their interactions should be favored over processes and tools. To ensure that products meet the market's needs, interactions with customers should emphasize collaboration, not contract negotiation. To promote flexibility, responding to change should have priority over following a plan. To maximize the practical benefits, speed and action-oriented learning should be valued more than the exhaustive collection of theoretical information.

Confirming what we have seen in our work supporting transformations, the study found that many companies are on the path toward deploying agile development. These companies have already divided the engineering process into small phases with regular feedback. As noted above, many of the phases are still too long to allow for significant product changes far into the engineering process.

Companies in the forefront of deploying agile are gaining a competitive advantage by reducing project delays and deviations from cost targets. In our study, practitioners of agile (companies in which the development process spans several smaller phases with regular feedback on progress) complete 59 percent of projects on time, compared with nonpractitioners, which complete only 43 percent on time.

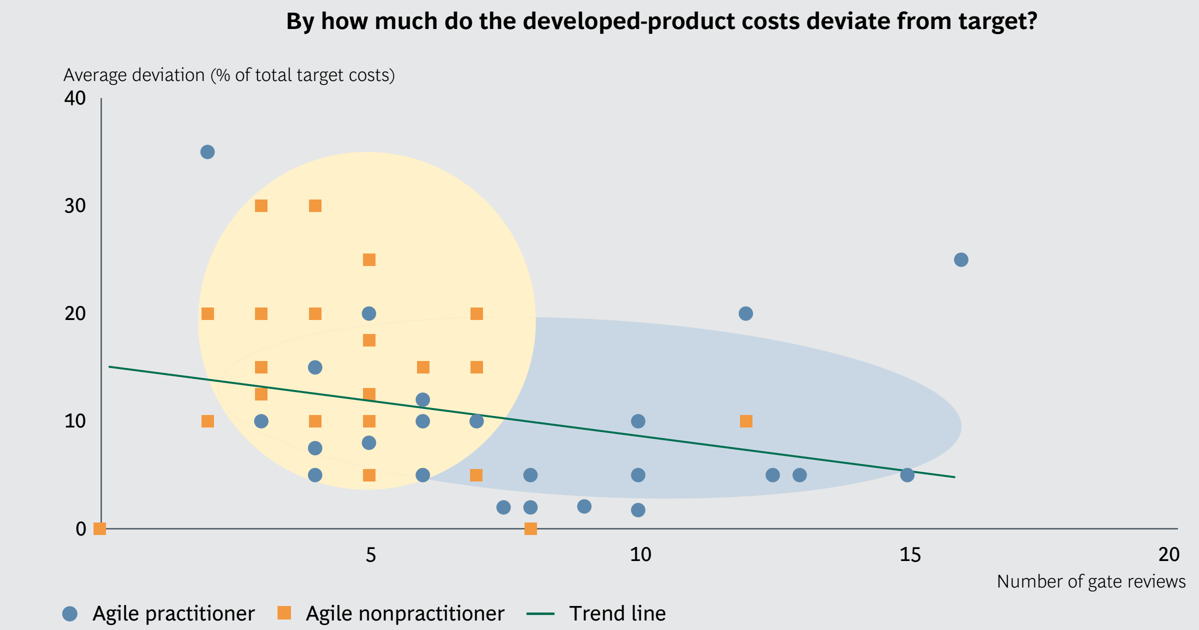
Agile practitioners' deviations from product target costs are, on average, more than 35 percent lower than deviations of nonpractitioners. Similarly, we found that the average deviation from product target costs decreases as the number of gate reviews in the development project increases. (See Exhibit 5.)

These findings suggest that companies deploying a fail-fast mentality and short iterative cycles are indeed able to make valuable refinements to products early in the development process. This allows them to avoid making significant investments of time and money as they proceed down the wrong path.

For example, by introducing the agile methodology, we helped a North American manufacturer of agricultural machinery reduce time and costs across several dimensions. Time to market declined by 20 percent and costs relating to quality—as measured by warranty expenses—declined by as much as 50 percent.

To reap these benefits, companies should implement agile in software-driven tasks and in the development of their products' electrical systems and electronics. A best-practice approach entails combining different agile methodologies. For exam-

Exhibit 5 | Short Development Cycles and Iterative Feedback Loops Reduce Cost Overruns



Source: Lean engineering benchmarking study, Laboratory for Machine Tools and Production Engineering, RWTH Aachen University, and BCG.

ple, with the Scrum method, a project is divided into two- to four-week "sprints." In each sprint, the team develops a potential prototype for the final product, integrating regular feedback. Roles are clearly defined: the "product owner" formulates and prioritizes product requirements and provides feedback; the development team works on designing the product; and the ScrumMaster manages the process. Scrum processes are designed to be flexible and adaptable. Rather than enforcing adherence to rigid processes, the goal is to empower people to collaborate and make decisions quickly and effectively.

The use of Scrum can be complemented by the *kanban* work-management system, whereby the workflow is split into sequences—from the definition of a task to its completion. These sequences are publicly displayed on a *kanban* board. Team members take assignments from a queue that reflects the workflow sequence. Explicit limits are set for the number of work-in-progress items at each stage of the workflow. The team measures cycle time and optimizes processes with the goal of making cycle time as short and predictable as possible. The emphasis is on just-in-time completion of tasks, without overloading team members.

Best practices also entail strongly linking processes that use the agile methodology to other engineering processes that follow the traditional, long-cycle "waterfall" methodology. For example, teams should have a regular forum and meeting schedule for updating each other on the status of their processes and sharing lessons learned.

A lean transformation of the product development process requires a comprehensive program that builds capabilities in each dimension of lean engineering.

Starting the Journey

A lean transformation of the product development process requires a comprehensive program that builds capabilities in each dimension of lean engineering. Companies starting the journey should seek to emulate the approaches applied by lean champions.

Product. Lean champions design a modular, standard portfolio that spans all product lines. By designing reusable modules, or components, and facilitating their utilization, champions reduce the engineering effort and resources required for each project and product. They adjust their operating model to smoothly transition their way of working from "custom" to "standard." They apply these adjustments to processes, roles, documentation, and tools relating to products and modules. They also integrate suppliers into their processes early on and collaborate with them to develop modules.

Processes. Lean champions embrace agile processes and a fail-fast mentality rather than waiting for market feedback at the end of a single, long development phase. They regularly visualize the entire engineering process to achieve a comprehensive understanding of the nature, timing, and interdependencies of all process steps. This transparency helps them identify bottlenecks as well as opportunities to reduce time to market. Borrowing from the know-how and methods utilized in the software industry, they then identify process steps that are suitable for applying the Scrum methodology to hardware development. This iterative, fast-cycle approach allows these companies to rapidly create and recalibrate the product under development.

Leadership and Behavior. Lean champions typically enable teams' cross-functional collaboration by creating standard feedback loops and information flows. By specifying the timing, tasks, and decision rights for each function affected by the engineering process, champions ensure that the representatives of these functions do not need to rely on their own individual initiative to get involved. Visual management tools, such as lean boards and T-card systems, facilitate collaboration by giving transparency to the activities of work streams and functions.

Enablement and Tools. Lean champions create and implement tools that support their objectives for faster development processes. They recognize that capturing the time and flexibility advantages of development cycles measured in weeks requires abandoning tools that take months to produce—for example, a physical mock-up. To use the right tools for their lean processes, champions adopt new technologies, such as 3-D printing, rapid prototyping, and digital engineering. These tools are selected on the basis of their ability to meet a process step's timing, quality, and precision requirements and, most important, the ease with which they can be integrated with existing tools and process steps.

Automotive and engineered-product companies in the forefront of lean engineering are already capturing significant competitive advantages in terms of quality, speed, and cost. The follower-to-champion transformation will be a multiyear effort, but the rewards are tangible. As our experience and comprehensive benchmarking study have shown, companies that apply the right approach to building their lean-engineering capabilities can expect to develop better products faster and with fewer resources.

NOTE
1. "Cost-cutting VW baffles experts with plans for new Phaeton," *Automotive News*, January 28, 2015, http://www.autonews.com/article/20150128/COPY01/301289974/cost-cutting-vw-baffles-experts-with-plans-for-new-phaeton.

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