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Resource revolution:
Gathering force

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This Quarter

More than seven years ago, Matt Rogers and I, along with colleagues from the McKinsey Global Institute (MGI) and McKinsey's energy practice, coauthored a report and *McKinsey Quarterly* cover story suggesting that radical improvements in energy efficiency would be necessary as billions of emerging-market consumers entered the ranks of the middle class. The scope of our research has expanded beyond energy over the years. So has our sense of the magnitude of the change needed, which MGI and our Firm's sustainability practice began describing two years ago as a "resource revolution" in another report and *Quarterly* cover story.

The means of achieving that revolution are now taking shape. As Matt and McKinsey alumnus Stefan Heck describe in their article, "Are you ready for the resource revolution?," advances in information technology, nanotechnology, materials science, and biology are creating the potential for a third Industrial Revolution, which will enable strong economic growth with much lower resource consumption than was needed in the past. This hopeful story is just beginning to unfold, but it raises a profound new set of management opportunities and challenges, which Matt and Stefan elaborate in their article and in their new book, *Resource Revolution*. McKinsey's David Frankel, Ken Ostrowski, and Dickon Pinner also weigh in, describing the top-management implications of solar energy's rapidly improving economics. So do Environmental Defense Fund president Fred Krupp and energy expert Daniel Yergin.

The resource revolution is one of many topics where the *Quarterly* has been a good place to follow the evolution of our Firm's thinking over time. As part of the publication's 50th anniversary this year, we'll be flagging some of those topics with the "Q50" symbol that appears at the bottom of this essay. We began using it online in February as a means of identifying content that supports our aspiration to look ahead this year toward next frontiers in business and management while building on a 50-year foundation of insight. The most prominent example in this issue is our package on "The future of lean," the operating principles that originated with Toyota and over the past 50 years have revolutionized a range of sectors, including services, whose introduction to lean has been well chronicled in the *Quarterly*. In the years ahead, say McKinsey's Ewan Duncan and Ron Ritter, a host of new developments suggest that lean's best is yet to come. Another topic that's been addressed in the *Quarterly* for a long time is gender bias facing women in top management. As Sandrine Devillard and her colleagues remind us in a summary of their latest research, some of the subtle cultural issues that undermine progress have been around since at least 1976, when McKinsey's Jim Bennett wrote about them in these pages.

The next *Quarterly* will focus entirely on connections between the future of management and our thought-leadership heritage, including analysis of disruptions under way, the trend breaks they signify, and the implications for strategy, leadership, organizational effectiveness, marketing, the role of business in society, the nature of innovation, and much more. We hope that this issue whets your appetite.

Scott Nyquist
Director, Houston office

Q50

On the cover

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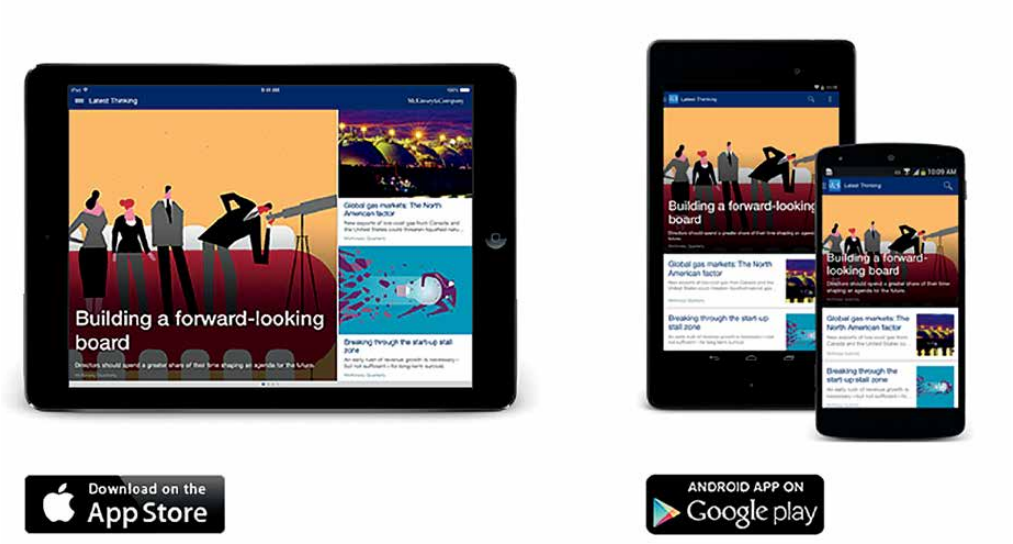

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Finding the sweet spot for allocating innovation resources

Vanessa Chan, Marc de Jong, and Vidyadhar Ranade

A survey finds that when it comes to reallocating R&D expenditures, more isn't necessarily better.

Mounting evidence finds that the habit of allocating the same levels of resources to the same business units year after year undermines corporate performance—and even lowers the odds of a lengthy tenure for CEOs.[1] Put another way, in a fast-changing competitive environment, companies that succumb to resource inertia will probably struggle to meet their strategic goals.

New McKinsey research paints a complementary, though more nuanced, picture for reallocating innovation and R&D resources. Our survey of senior executives at companies with revenues of more than $1 billion showed that the average level of annual R&D reallocation is relatively consistent—12.7 to 13.7 percent—regardless of a company's innovation performance (see sidebar, "About the survey"). Parsing the data in a finer way to highlight the distribution of reallocation behavior further emphasizes the fact that when it comes to reallocating R&D expenditures, the message is subtler than "more is better."

Reallocation sweet spots?

As the exhibit shows, top-quartile innovators may be identifying sweet spots where adequate (yet still substantial) levels of R&D reallocation are bolstering innovation performance: 75 percent of executives at top-quartile companies say they reallocated 6 to 30 percent of their R&D budgets in each of the past three years compared with 37 percent of the respondents at bottom-quartile performers.

Only 5 percent of the top-quartile innovators reallocated more than 30 percent of their R&D budgets each year.

Exhibit

Annual R&D reallocation, on average, is relatively consistent, yet top-quartile innovators may be identifying sweet spots where reallocation bolsters innovation performance.

Reported annual reallocation of R&D/innovation budget over past 3 years, for companies with revenues >$1 billion

[1]Figures may not sum to 100%, because of rounding.

Source: 2013 McKinsey Global Survey on innovation-portfolio management

About the survey

These findings are based on a July 2013 survey of 1,241 senior executives. For this article, we focused on the 258 executives from companies with revenues of more than $1 billion. Respondents were asked a series of questions about the performance, management practices, and challenges associated with their companies' or business units' R&D and innovation portfolio.

To determine which companies were high performers, we asked questions about the rate of organic growth relative to that of competitors over the past three years and the proportion of organic growth attributable to products generated in-house over that period. We also included a self-assessment of corporate innovation performance. The responses were indexed, normalized, and combined to construct an innovation-performance index. Companies ranking in the top quartile are classified as high performers.

By contrast, 16 percent of the bottom-quartile innovators did so, and 9 percent of the bottom-quartile companies reallocated more than 40 percent of their R&D budgets. That's a big adjustment for any large organization and a threshold none of the top-quartile companies breached.

The poorest performers, in fact, seem divided between two camps. At one extreme, there's a near-majority of companies that are sleepwalking through their R&D-reallocation decisions, moving 5 percent or less of their R&D resources a year among businesses and divisions. At the other extreme, a second group is placing huge bets in an attempt to jump-start performance or perhaps to make drastic course corrections. Time—and further research—are needed to determine if these low-performing innovators have awakened in time or are in fact doing additional damage through panicky reallocations.

Take a hard look

The nuanced picture our research paints should not be surprising. After all, the right amount of annual R&D reallocation for an individual company depends on its industry, strategy, and competitive situation. Furthermore, shifts don't necessarily translate

into quick performance gains. However, the data suggest that any large company on the left-hand side of the chart (below 10 percent and certainly below 5 percent) should investigate its levels of R&D reallocation to make sure that its portfolio is aligned with its innovation strategy and that it isn't nurturing stalled projects at the expense of more promising alternatives. And while operating closer to the sweet spot highlighted on the exhibit doesn't guarantee success with innovation, a steady, consistent level of R&D reallocation year after year is highly consistent with successful innovation at scale.

[1] For more, see Stephen Hall, Dan Lovallo, and Reinier Musters, "How to put your money where your strategy is," *McKinsey Quarterly*, March 2012; and Stephen Hall and Conor Kehoe, "How quickly should a new CEO shift corporate resources?," *McKinsey Quarterly*, October 2013, both available on mckinsey.com.

The authors wish to thank Peet van Biljon for his contribution to this article.

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For more about the practices associated with top innovators, see *The Eight Essentials of innovation performance*, on mckinsey.com.

High-performing boards: What's on their agenda?

Chinta Bhagat and Conor Kehoe

Directors report that they have a greater impact as they move beyond the basics.

Five or so years after the financial crisis, the pressure on boards and directors to raise their game remains acute. A recent survey of more than 770 directors from public and private companies across industries around the world and from non-profit organizations suggests that some are responding more energetically than others.[1] The survey revealed dramatic differences in how directors allocated their time among boardroom activities and, most tellingly, in the respondents' view of the effectiveness of their boards. More than one in four of the directors assessed their impact as moderate or lower, while others reported having a high impact across board functions. So what marks the agenda of a high-performing board?

A hierarchy of practices

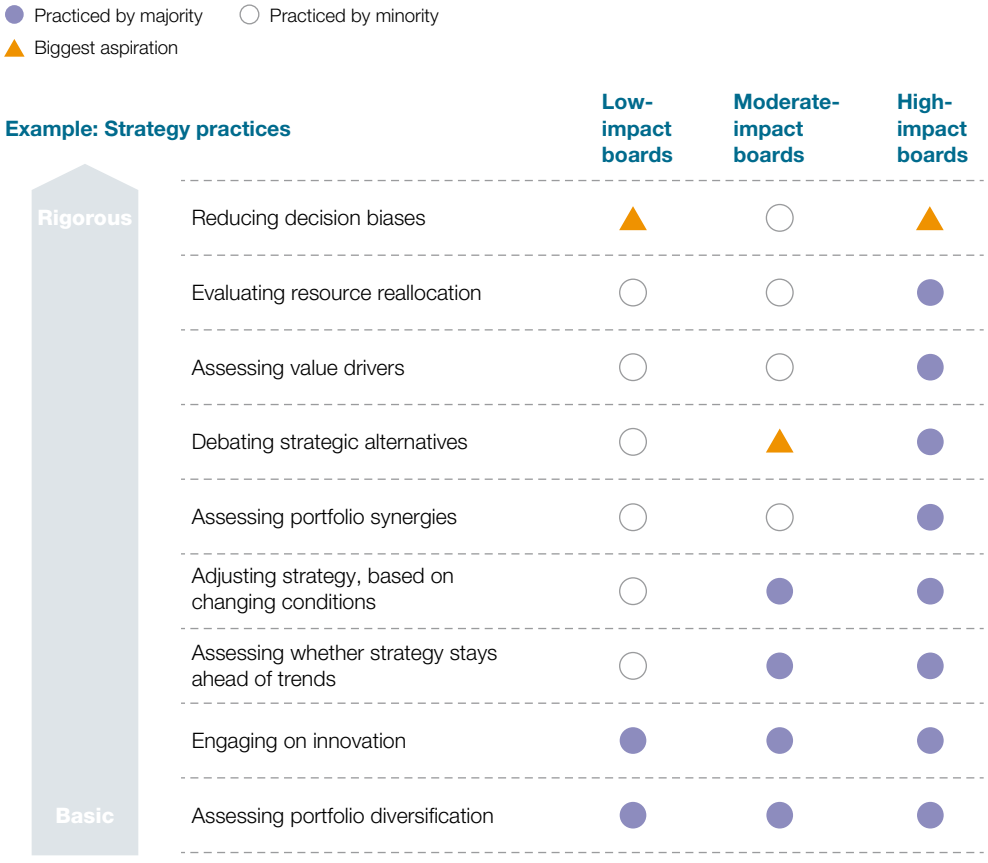
Our research suggests that the distinction between higher and lower impact turns on the breadth of the issues directors tackle and on the time dedicated to them. We drilled down to detailed board practices across the functions to which directors devote much of their attention: strategy, compliance, and M&A, as well as performance, risk, and talent management. It appears that boards progress through a hierarchy of practices that's analogous to Maslow's hierarchy of needs.[2] Directors who report having a low to moderate impact said that their boards undertake "the basics" of ensuring compliance, reviewing financial reports, and assessing portfolio diversification, depending on the function. Directors reporting that their boards have a higher impact undertake these activities, as well, but add a series of other practices in every function.

In the area of strategy, for example, this means becoming more forward looking. Boards with a moderate impact incorporate trends and respond to changing conditions. More involved boards analyze what drives value, debate alternative strategies, and evaluate the allocation of resources. At the highest level, boards look inward and aspire to more "meta" practices—deliberating about their own processes, for example—to remove biases from decisions (Exhibit 1).

We observed a similar hierarchy across other board functions. In performance

Exhibit 1

Boards appear to progress through a hierarchy of practices, with high-impact boards often employing more rigorous practices.



Source: April 2013 McKinsey Global Survey of 772 directors on board practices

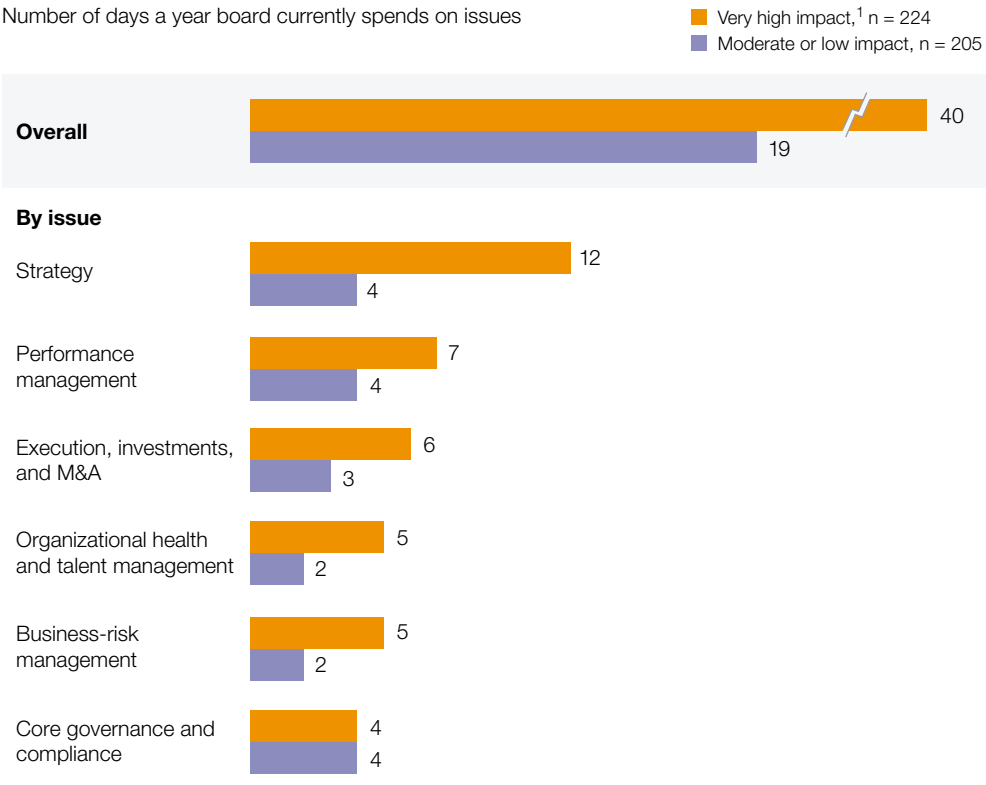
management, for instance, many boards start with a basic review of financial metrics. More involved boards add regular performance discussions with the CEO, and boards at still higher levels of engagement analyze leading indicators and aspire to review robust nonfinancial metrics. In the areas of risk, M&A, and talent management boards follow comparable progressions. (For more, see "Building a forward-looking board," on page 119.)

A greater time commitment

Working at a high level takes discipline—and time. Directors who believe that their activities have a greater impact report spending significantly more time on

Exhibit 2

Board members with very high impact invested eight extra workdays a year on strategy.



[1] Figures do not sum to total, because of rounding.

Source: April 2013 McKinsey Global Survey of 772 directors on board practices

these activities, on average, than those who serve on lower-impact boards. We found that directors reporting that they had a very high impact worked for their boards about 40 days a year, while those who said that their impact was moderate or lower averaged only 19.[3] Higher- and lower-impact directors spend the same amount of time on compliance-related activities: about four days a year. By contrast, higher-impact board members invest an extra eight workdays a year on strategy. They also spend about three extra workdays on each of the following: performance management, M&A, organizational health, and risk management (Exhibit 2).

The data suggest that less engaged boards correctly identify the next step up in the hierarchy but underestimate the time it would take to meet this aspiration. When low- to moderate-impact directors are asked how much time they ideally should spend on their duties, they suggested increasing the number of

What surveys can and can't tell us

Survey-based research can be an effective means of aggregating information from diverse respondents about fairly granular attitudes or activities, such as detailed governance practices. However, as Professor Phil Rosenzweig, of the International Institute for Management Development (IMD), and others have pointed out, there's also a danger that other factors will influence respondents, undermining the validity of the survey results.[1] For example, a "halo effect"—the tendency to make specific inferences on the basis of general impressions—might make board members more inclined to rate their efforts highly if their companies have been successful. We recognize this difficulty and did not seek to correlate the directors' self-reported evaluations with financial performance. But it is possible that directors who devote a large number of days to their boards come to believe that they are having a greater impact simply as a result of making that investment of time.

Some additional checks, however, showed that this isn't necessarily true. First, we split the number of days when directors worked into quartiles. Not surprisingly, this showed a wide range of time commitments. However, it also showed that those claiming to have a high impact were by no means all in the top quartile of directors by days worked. This suggests that a board member's view of his or her impact is influenced by matters other than just the amount of time spent on the job.

We also cut board practices by quartile of days worked. From this analysis, we saw that high-impact boards appear to have an even richer set of strategic priorities than the most time-intensive boards (those in the top quartile). In addition, we found much less differentiation among the practices of the second-, third-, and bottom-quartile board members when cut by days worked—which again suggests that when directors assessed the impact of their activities, they were doing more than just counting hours served.

Factors beyond days spent, of course, affect the richness of a board's agenda and how directors rate their impact. For example, a board locked in crisis or subject to new and complex regulation may need to work hard just to keep the business running. The size of a board and the skills of its members have also been shown to affect efficiency and effectiveness. And in all situations, a skilled chair can make boards significantly more efficient by setting high standards and taking action to help members improve their contribution.

[1] See Phil Rosenzweig, "The halo effect, and other managerial delusions," *McKinsey Quarterly*, February 2007, mckinsey.com.

days to 27, from 19. While spending more time can never assure a high impact (see sidebar, "What surveys can and can't tell us"), even very high-impact directors would increase their commitment to 45 days, from 40.

A final implication of our survey is that CEOs need not fear that a more engaged board may constrain their prerogative to set a company's direction. Highly committed boards are not spending the extra time supplanting management's role in developing strategic options. Rather, they are building a better understanding of their companies and industries, while helping senior teams to stress-test strategies and then reallocate resources to support them. Some CEOs find that task to be lonely and difficult when they face internal "barons" who protect their fiefs. In short, engaged boards can still be supportive of management. And the directors serving on them, our research suggests, are not only more effective but also more satisfied with their work.

[1] The online survey, in the field from April 9 to April 19, 2013, garnered responses from 772 corporate directors, 34 percent of them chairs. We asked respondents to focus on the single board with which they are most familiar. Overall, 166 respondents represent publicly owned businesses and 606 privately owned ones, including the full range of regions, industries, and company sizes.

[2] Psychologist Abraham H. Maslow contended that human needs are structured in a hierarchy; as each level of needs is satisfied, the next higher level of unfulfilled needs becomes predominant. See Abraham H. Maslow, "A theory of human motivation," *Psychological Review*, 1943, Volume 50, Number 4, pp. 370–96; and Abraham H. Maslow, *Motivation and Personality*, first edition, New York, NY: Harper & Brothers, 1954.

[3] Directors who assessed their impact as high worked about 27 days a year.

The authors would like to acknowledge the contributions of Frithjof Lund and Eric Matson to the development of this article.

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The rising strategic risks of cyberattacks

Tucker Bailey, Andrea Del Miglio, and Wolf Richter

Research by McKinsey and the World Economic Forum points to a widening range of technology vulnerabilities and potentially huge losses in value tied to innovation.

More and more business value and personal information worldwide are rapidly migrating into digital form on open and globally interconnected technology platforms. As that happens, the risks from cyberattacks become increasingly daunting. Criminals pursue financial gain through fraud and identity theft; competitors steal intellectual property or disrupt business to grab advantage; "hacktivists" pierce online firewalls to make political statements.

Research McKinsey conducted in partnership with the World Economic Forum suggests that companies are struggling with their capabilities in cyberrisk management.[1] As highly visible breaches occur with growing regularity, most technology executives believe that they are losing ground to attackers. Organizations large and small lack the facts to make effective decisions, and traditional "protect the perimeter" technology strategies are proving insufficient. Most companies also have difficulty quantifying the impact of risks and mitigation plans. Much of the damage results from an inadequate response to a breach rather than the breach itself.

Complicating matters further for executives, mitigating the effect of attacks often requires making complicated trade-offs between reducing risk and keeping pace with business demands (see sidebar "Seizing the initiative on cybersecurity: A top-team checklist"). Only a few CEOs realize that the real cost of cybercrime stems from delayed or lost technological innovation—problems resulting in part from how thoroughly companies are screening technology investments for their potential impact on the cyberrisk profile.

These findings emerged from interviews with more than 200 chief information officers, chief information-security officers, regulators, policy makers, technology vendors, law-enforcement officials, and other kinds of practitioners in seven sectors across the Americas, Europe, the Middle East and Africa, and Asia.[2] We also drew on a separate McKinsey executive survey on cyberrisk, supplementing this research with an analysis of McKinsey Global Institute (MGI) data on the value-creation potential of innovative technologies. It showed that the eco-

Seizing the initiative on cybersecurity:
A top-team checklist

With trillions of dollars in play and cyberresiliency affecting a growing range of business issues—business continuity, customer privacy, and the pace of innovation, to name just a few—it's clear that current operating models for combatting attacks aren't up to the task. Often, they are compliance driven and technology centric. Instead, they must be grounded in collaboration across business functions. That requires active engagement by the CEO and other senior leaders who understand the broad strategic risks of inaction—and can catalyze change. We have developed a checklist of practices that can help top teams as they remap the boundaries of their cybersecurity operating models:

1. Prioritize information assets by business risks. Most companies lack sufficient insight into the precise information assets they need to protect—for example, the damage that might result from losing the intellectual property behind a new manufacturing process. Business leaders need to work with cybersecurity teams to assess and rank business risks across the value chain.

2. Differentiate protection by the importance of assets. Assigning levels of controls, such as encryption and more rigorous passwords for lower-value assets, will allow management to invest time and resources in protecting the most strategic information.

3. Integrate security deeply into the technology environment to achieve scale. Executives need to instill the mind-set that security isn't something bolted onto projects. Instead, every facet of the growing technology environment—from developing social-network applications to replacing hardware—needs to be shaped by the awareness of new vulnerabilities.

nomic costs of cybercrimes could run into the trillions of dollars.

Areas of business concern

From our interviews and survey research, four areas of concern emerged on how executives perceive cyberrisks, their business impact, and the readiness of companies to respond:

More than half of all respondents, and 70 percent of executives from financial institutions, believe that cybersecurity is a strategic risk for their companies. European companies are slightly more concerned than American ones. Notably,

4. Deploy active defenses to uncover attacks proactively. Massive intelligence is available about potential attacks. Much as top teams are organizing strategy around big data analytics, they must ensure that their companies can aggregate and model new information to establish robust defenses.

5. Test continuously to improve response plans. Teams responsible for diverse functions, such as public affairs and customer service, where technology isn't the core focus, must sharpen their ability to meet breaches. Running realistic cyber-war games on an ongoing basis can rally teams from across functions and build organizational "muscle memory."

6. Engage frontline personnel to aid their understanding of valuable information assets. The biggest vulnerabilities often stem from everyday use of e-mail and Internet technology. Segment the risks and then train employees, targeting behavior that undermines security.

7. Incorporate cyberresistance into enterprise-wide risk-management and governance processes. Assessments of risks from cyberattacks must be integrated with other kinds of risk analysis and presented in relevant management and board discussions. Moreover, cybersecurity must dovetail with broader enterprise-governance functions, such as human resources, regulatory compliance, and vendor management.

some executives think internal threats (from employees) are as big a risk as external attacks.

Equally worrisome, a large majority of executives believe that attackers will continue to increase their lead over corporate defenses. Sixty percent of the executives interviewed think the sophistication or pace of attacks will increase somewhat more quickly than the ability of institutions to defend themselves. Product companies, such as high-tech firms, are most concerned about industrial espionage. The leaking of proprietary knowledge about production processes may be more damaging than leaks of product specifications, given the

pervasiveness of "teardown" techniques and the legal protections afforded to product designs. Service companies are more concerned about the loss and release of identifiable information on customers and about service disruptions.

According to McKinsey's ongoing cyberrisk-maturity survey research, large companies reported cross-sector gaps in their risk-management capabilities. Ninety percent of those most recently surveyed had "nascent" or "developing" ones. Only 5 percent were rated "mature" overall across the practice areas studied (exhibit). Notably, we found no correlation between spending levels and risk-management maturity. Some companies spend little but do a comparatively good job of making risk-management decisions. Others spend vigorously, but without much sophistication. Even the largest firms had substantial room for improvement. In finance, for instance, senior nontechnical executives struggled to incorporate cyberrisk management into discussions on enterprise risk management and often couldn't make informed decisions, because they lacked data.

Concerns about cyberattacks are starting to have measurable negative business implications in some areas. In high tech, fully half of the survey respondents said they would have to change the nature of their R&D efforts over time. There is noticeable concern, as well, that cyberattacks could slow down the capture of value from cloud computing, mobile technologies, and health-care technologies. Some 70 percent of the respondents said that security concerns had delayed the adoption of public cloud computing by a year or more, and 40 percent said such concerns delayed enterprise-mobility capabilities by a year or more.

Cybersecurity controls are having a significant impact on frontline productivity, too. About 90 percent of the respondents overall said that controls had at least a moderate impact on it. Half of the high-tech executives cited existing controls as "a major pain point" that limited the ability of employees to collaborate.

While there is broad agreement among executives that concerted efforts by policy makers, companies, and industry associations will be needed to reduce threats, there is considerable disagreement about how a consensus might take shape. And executives worry that new regulations may be grounded in outdated techniques and that regulators' skills and capabilities may be insufficient.

A global economic penalty

Looking forward, if the pace and intensity of attacks increase and are not met with improved defenses, a backlash against digitization could occur, with large negative economic implications. Using MGI data on the technologies that will truly matter to business strategy during the coming decade, we estimate that over the next five to seven years, $9 trillion to $21 trillion of economic-value creation, worldwide, depends on the robustness of the cybersecurity environment (see sidebar "About the research").

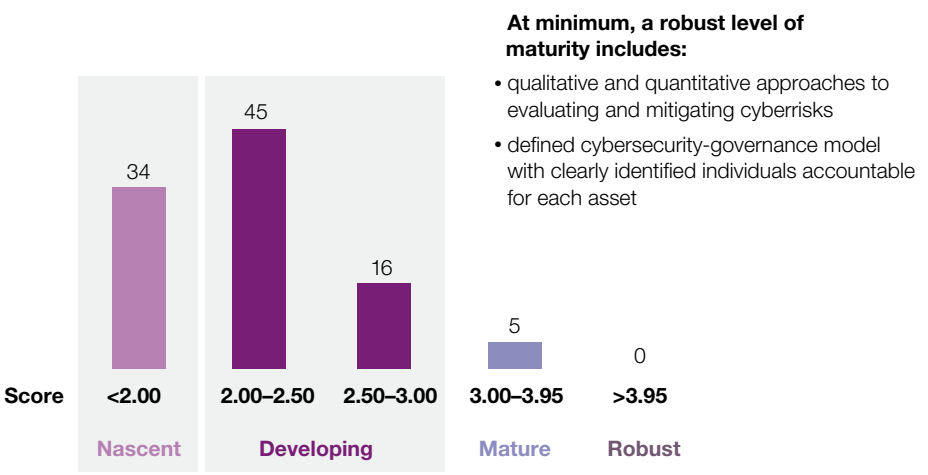
About the research

We modeled alternative scenarios for 2020, starting with estimates of the economic value that could be achieved in an environment where organizations and governments adopt robust cyberresilience strategies. We then estimated how that value might diminish, first, if institutions muddle through and make no substantive changes to current approaches, allowing cyberattackers to retain an advantage over defenders and, second, if a step-change increase in attacks prompts severe regulatory responses that constrict the use of technologies and produce a backlash against digitization. The basis of our economic analysis was a 2013 McKinsey Global Institute (MGI) report that focused on the speed and scope of, and the economic value at stake from, a dozen economically disruptive technologies, among them cloud technology, the mobile Internet, and the Internet of Things. For more, see the full MGI report, *Disruptive technologies: Advances that will transform life, business, and the global economy* (May 2013), on mckinsey.com.

Exhibit

A large majority of surveyed companies had nascent or developing cyberrisk-management capabilities.

Maturity level of companies' overall cyberrisk management, on a scale of 1 to 4, where 4 is strongest, % of companies



Source: 2013 McKinsey Global Survey on cyberrisk-management maturity, including nearly 100 institutions across Africa, the Americas, Europe, and the Middle East

Consider, for example, cloud computing. In an environment where a solid cyberresilience ecosystem accelerates digitization, the private and government sectors would increase their use of *public* cloud technologies,[3] with enhanced security capabilities allowing widespread deployment for noncritical workloads. Private clouds would handle more sensitive workloads. In this case, we estimate that cloud computing could create $3.72 trillion in value by 2020. However, in an environment of stepped-up cyberattacks, public clouds would be underutilized, given increased fear of vulnerabilities and higher costs from compliance with stricter policies on third-party access to data and systems. Such problems would delay the adoption of many systems and reduce the potential value from cloud computing by as much as $1.4 trillion.

These dynamics could play out in many areas, with the proliferation of attackers' weapons leading to widespread and highly visible incidents that trigger a public backlash and push governments to enforce tighter controls, which could dramatically decelerate the pace of digitization. Indeed, our interviews and workshops with executives from a variety of sectors reinforce the view that the cybersecurity environment may be getting more difficult and that early elements of a backlash are already beginning to materialize.

[1] For more, see the full report, *Risk and Responsibility in a Hyperconnected World* (January 2014), on mckinsey.com.

[2] The Risk and Responsibility in a Hyperconnected World initiative was launched at the World Economic Forum's annual meeting in 2012. Over the past year, the Forum, in partnership with McKinsey, has continued a dialogue with executives and policy makers through interviews and workshops and through surveys exploring strategies for building a vigorous cyberresilience capability at the institutional level. We augmented our research with parallel McKinsey cyberrisk-maturity survey data on cyberresiliency.

[3] Where cloud-computing resources are offered by third-party service providers rather than hosted in-house.

The authors would like to acknowledge David Chinn, James Kaplan, Roshan Vora, and Allen Weinberg for their contributions to the development of this article.

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Why gender diversity at the top remains a challenge

Sandrine Devillard, Sandra Sancier-Sultan, and Charlotte Werner

McKinsey's survey of global executives finds that corporate culture and a lack of convinced engagement by male executives are critical problems for women.

In a 1976 *McKinsey Quarterly* article, the Firm's Jim Bennett noted that companies taking an honest look at how they handled the advancement of women were likely to uncover a number of "thorny attitude-based problems" that "will take much longer and prove much more difficult to solve" than "sex-based differences in benefits plans and obviously biased employment literature."[1] Our latest gender-diversity research—a survey of 1,421 global executives—suggests that cultural factors continue to play a central role in achieving (or missing) diversity goals. That underscores just how long lived and challenging the issues flagged by Bennett are.[2]

Women executives are ambitious and, like men, say they are ready to make some sacrifices in their personal lives if that's what it takes to occupy a top-management job. Many, however, are not sure that the corporate culture will support their rise, apparently with some justification. Although a majority of organizations we studied have tried to implement measures aimed at increasing gender diversity among senior executives,[3] few have achieved notable improvements.

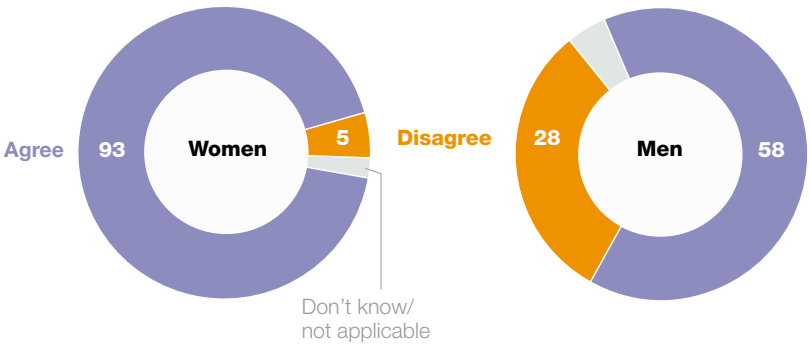
Among the elements factoring into failure or success, we found that corporate culture was the key. In particular, our 2013 survey strongly suggests that prevailing leadership styles among top managers and performance models stressing that executives make themselves available 24/7 can be important barriers to women's advancement. Another issue is the divergence of views between men and women executives, from middle management to the C-suite, on the difficulties women face in advancing. That problem is paired with lingering doubts among men about the value of diversity programs, particularly among men who are less familiar with the range of forces influencing women's career trajectories. CEOs seeking to design diversity programs that truly bring about change must take account of these factors.

Exhibit

Fewer men acknowledge the challenges female employees face at work.

% of respondents[1]

"Even with **equal skills and qualifications, women have much more difficulty** *reaching top-management positions."*



[1] Responses for "strongly agree" and "agree" are combined, as are those for "strongly disagree" and "disagree." Female respondents = 797; male = 624.

Source: 2013 McKinsey Global Survey of 1,421 global executives on gender diversity

Cultural factors that limit progress

Women respondents say that they aim just as high as their male peers do. Seventy-nine percent of all mid- or senior-level women want to reach top management, compared with 81 percent of men. Senior women executives just one step away from the C-suite are more likely to agree strongly that they have top-management ambitions.

Yet our survey also shows that many are less certain they will reach the top: 69 percent of senior women say they are confident they'll reach the C-suite, as opposed to 86 percent of their male peers. We compared women who feel confident that they can rise with those who are less confident and analyzed their answers about personal and collective factors that can support or inhibit career success. We found that a favorable environment and cultural factors weighed twice as heavily as individual factors in determining how confident women felt about reaching top management.

Women who are more confident of their ability to rise tend to say that the leadership styles of their companies are compatible with women's leadership and communication styles, and that women are just as likely as men to reach the top there. Consistently, the absence of diversity in leadership styles was a challenge for many women: almost 40 percent of female respondents said that women's

leadership and communication styles don't fit with the prevailing model of top management in their companies.

Performance models for work–life balance issues also tilt against women. Most men and women agree that a top-level career implies "anytime, anywhere" availability to work and that this imposes a particularly severe penalty on female managers. When asked whether having children is compatible with a top-level career for women, 62 percent of all respondents agree—but a much larger share (80 percent) think that's true for men.

Male perceptions

A significant cultural factor affecting women's ability to reach top management is the engagement and support of men. While about three-quarters of men believe that teams with significant numbers of women perform more successfully, fewer recognize the challenges women face. Only 19 percent strongly agree that reaching top management is harder for women, and men are much more likely to reject the idea that the climb is steeper for women (exhibit). We also found that men are less likely than women to see value in diversity initiatives and more likely to believe that too many measures supporting women are unfair to men. Finally, while nearly all male and female executives express some level of agreement that women can lead as effectively as men do, male respondents are not as strongly convinced.

These are among the reasons that year after year, and again in 2013, women remain underrepresented at the top of corporations, across all industries and countries. Those disappointing results persist despite a body of research suggesting that companies with more women in top management tend to perform better, both organizationally and financially, and despite decades of effort by many companies.[4] The upshot is that there's still room for firmer engagement among male executives, for more inclusivity, and for a more comprehensive ecosystem of measures—which will benefit from a strong, visible commitment by the CEO and the executive committee.

[1] James E. Bennett, "Sex bias: Still in business," *McKinsey Quarterly*, Number 3, Summer 1976.

[2] We interviewed 624 male and 797 female executives in the summer of 2013. A full range of regions, industries, company sizes, tenures, and functional specialties was represented. For more, see the full report, *Women Matter 2013–Gender diversity in top management: Moving corporate culture, moving boundaries*, November 2013, mckinsey.com.

[3] See *Women Matter 2012–Making the Breakthrough*, March 2012, mckinsey.com.

[4] See *Women Matter: Gender diversity, a corporate performance driver*, October 2007; and *Women Matter 2: Female leadership, a competitive edge for the future*, October 2008, mckinsey.com.

The authors would like to acknowledge the contributions of Tiphaine Bannelier-Sudérie and Cecile Kossoff to this article.

Sandrine Devillard and **Sandra Sancier-Sultan** are directors in McKinsey's Paris office, where **Charlotte Werner** is an associate principal.

Industry dynamics

A new act for fracking?

Parker Meeks, Dickon Pinner, and Clint Wood

The latest wave of innovation could greatly improve production and lower costs.

The production of shale gas and light tight oil using hydraulic-fracturing (fracking) technologies has revolutionized the US energy industry. However, the data show that it takes a large number of wells—as many as 1,500—to reach peak production for each new basin, because optimizing fracking remains largely a matter of trial and error (exhibit). Over the next decade, our research suggests, several promising techniques could boost the precision of drilling and fracking, increasing the production of light tight oil and shale gas significantly—for the former, by nearly 40 percent in the United States alone. At the same time, these techniques could substantially lower costs and open up new regions to production.

Improved geological data, combined with better modeling techniques, for example, could increase individual well productivity and shorten learning curves. New technologies would allow more wastewater to be treated and reused rather than disposed of. Better IT tools could improve performance across the value chain (for instance, in supply chains and logistics). Finally, advances in nonwater fracking technologies, such as high-pressure gases, could make it possible to frack in water-constrained regions (notably China) while lowering production costs. Opportunities such as these underscore the potential of process innovations to yield continuous improvements even in breakthrough technologies, like fracking.

The authors would like to acknowledge the contributions of Claudio Brasca and Sara Hastings-Simon to this article.

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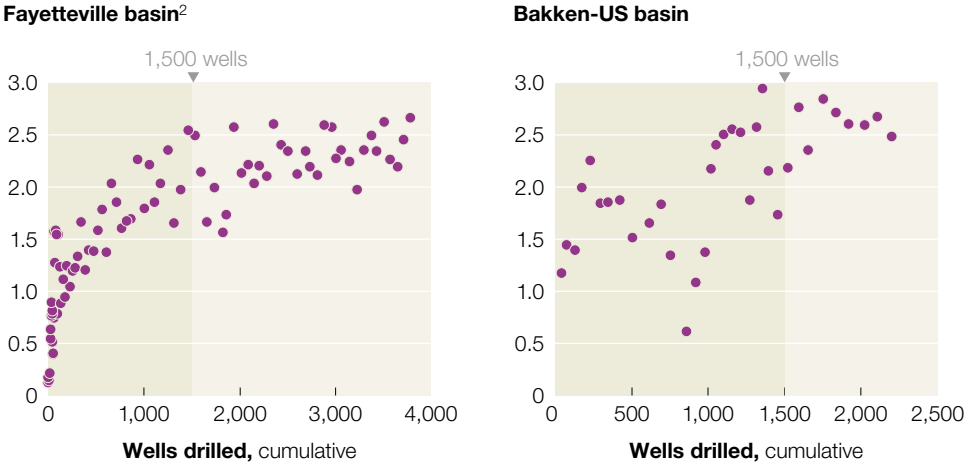
Exhibit

Learning curves for new shale-gas basins suggest approximately 1,500 wells must be drilled before initial production plateaus.

Initial production,[1] millions of cubic feet per day equivalent



[1]Based on reported initial production rates for first 2 calendar months of production.
[2]Includes both East and West Fayetteville.

Source: HPDI; McKinsey analysis

Industry dynamics

Monetizing mobile apps: Striking the right balance

Neha Ajmera, Livia Sato, and Brian Stafford

More companies are discovering that an application programming interface can turn their data into new revenue streams.

Mobile apps are becoming big business. Analysts estimate that app-related revenues reached $25 billion last year, on the way to more than $70 billion by 2017. App developers and the Apple and Google app stores aren't the only ones profiting from this boom. A small but growing portion of app revenues comes from organizations making their data available through application programming interfaces[1] (APIs)—gateways that, among other things, enable third-party app developers to leverage a company's aggregated data or selected services.

There are reasons not to pursue APIs, of course, starting with the desire of many companies to have more direct control over their data. But our analysis indicates that APIs are generating revenues in one of three ways for the companies that choose to contribute their data (exhibit). Under the pay-per-use model, a company makes its transactional data available to third-party apps that, for example, compare prices or analyze customer behavior. Subscription models are similar, but fees accrue during a subscription period rather than per use. Resource-usage and revenue-sharing models typically generate sales of a company's own products (for example, on an online storefront), from which the app developer too gets a cut.

As revenue opportunities and the potential for deep engagement with more customers grow, the role of APIs in broader business-planning discussions is expanding. In those conversations, it is essential for organizations to ensure that their desire to make money from their data does not interfere with their responsibilities as stewards of the customer's private data.

[1] APIs allow developers to access information from multiple companies and present it to mobile users in an app. In developing a travel app, for example, programmers would use the APIs from the websites of individual airlines to aggregate fares and flight schedules. Developers earn referral revenue when their mobile apps display products. (APIs can also create value by opening a company's internal capabilities to the world.)

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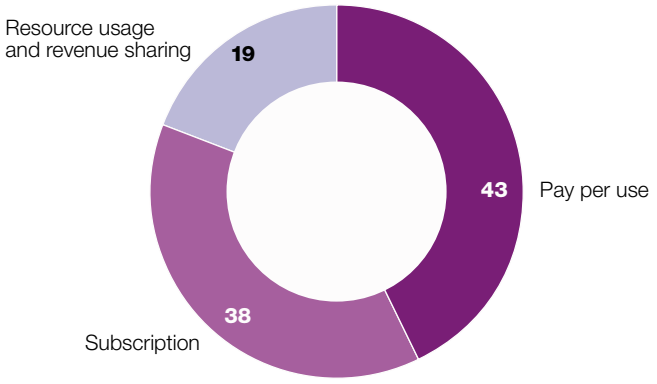
Exhibit

APIs are generating revenues in one of three ways for companies that choose to contribute their data.

Prevalence of open API[1] revenue models, June 2013, n = 9,357 APIs, %



[1] Application programming interfaces: accessible gateways that enable third-party app developers to leverage a company's aggregated data or selected services.

Source: MuleSoft's ProgrammableWeb (http://api.programmableweb.com); McKinsey analysis

Resource revolution: Gathering force

The outlines of the next industrial revolution, which will give companies extraordinary opportunities to make radical improvements in the way they use resources, are becoming clear. The lead article in this package examines five approaches that businesses can adopt, explores ways to overcome the principal managerial challenges, and describes the sort of global corporations that might be dominating the landscape 20 years from now. Separately, Environmental Defense Fund president Fred Krupp and analyst Daniel Yergin offer their own pertinent perspectives, while McKinsey authors look at the implications of solar energy's advance.

Are you ready for the resource revolution?

Stefan Heck and Matt Rogers

By developing the skills to integrate software into industrial hardware, substitute new materials into products, and build circularity into business flows, companies will be able to grasp extraordinary new opportunities.

Most cars spend more than 95 percent of their time sitting in garages or parking lots. When in use, the average occupancy per vehicle is well below two people, even though most cars have five seats. Roads are likewise extremely inefficient. Freeways can operate at peak throughput (around 2,000 cars a lane per hour) only when they are less than 10 percent covered by cars. Add more, and congestion lowers speeds and reduces throughput. Most roads reach anything like peak usage only once a day and typically in only one direction. (For a visualization of these dynamics, see “Time for a revolution,” on page 132.)

The story is similar for utilities. Just 20 to 40 percent of the transmission and distribution capacity in the United States is in use at a given time, and only about 40 percent of the capacity of power plants. The heat-rate efficiency of the average coal-fired power plant has not significantly improved in more than 50 years—an extreme version of conditions in many industries over the past century. Automotive fuel-efficiency improvement, for example, has consistently lagged behind economy-wide productivity growth.

Underutilization and chronic inefficiency cannot be solved by financial engineering or offshoring labor. Something more fundamental is required. We see such challenges as emblematic of an unprecedented

opportunity to produce and use resources far more imaginatively and efficiently, revolutionizing business and management in the process. Indeed, rather than facing a crisis of resource scarcity, the world economy will be revitalized by an array of business opportunities that will create trillions of dollars in profits.

To put this new era in context, think back to Adam Smith's *The Wealth of Nations* (1776), which identified three primary business inputs: labor, capital, and land (defined broadly as any resource that can be produced or mined from land or disposed of as waste on it). The two industrial revolutions the world has thus far seen focused primarily on labor and capital. The first gave us factories and limited-liability corporations to drive growth at scale. The second, from the late 1800s to the early 1900s, added petroleum, the electric grid, the assembly line, cars, and skyscrapers with elevators and air-conditioning, and it created scientific management, thus enabling corporate globalization. But neither revolution focused on Smith's third input: land and natural resources.

Our argument is relatively simple:

- Combining information technology, nanoscale-materials science, and biology with industrial technology yields substantial productivity increases.

- Achieving high-productivity economic growth in the developing world to support the 2.5 billion new members of the middle class presents the largest wealth-creation opportunity in a century.

- Capturing these opportunities will require new management approaches.

Rather than settling for historic resource-productivity improvement rates of one to two percentage points a year, leaders must deliver productivity gains of 50 percent or so every few years (exhibit).

The outlines of this next industrial revolution are starting to come into sharper focus: resource productivity is the right area of emphasis, and the opportunities for companies are extraordinary. In this article, we'll explore the business approaches most likely to unlock the potential and then highlight ways senior managers can

integrate tomorrow's new technologies, customers, and ways of working with the realities of today's legacy business environment.

Winning the revolution

We believe the businesses that capitalize most successfully on the resource revolution will employ five distinct approaches, either individually or in some combination. We explore all five of them in our new book, *Resource Revolution*, but focus here on three: substitution (the replacing of costly, clunky, or scarce materials with less scarce, cheaper, and higher-performing ones); optimization (embedding software in resource-intensive industries to improve, dramatically, how companies produce and use scarce resources); and virtualization (moving processes out of the physical world). The remaining two are circularity (finding value in products after their initial use)[1] and waste elimination (greater efficiency, achieved by means including the redesign of products and services). For more on the waste-elimination approach, see "Bringing lean thinking to energy," on page 103.

Businesses that have harnessed these five models include Tesla Motors, Uber, and Zipcar (now owned by Avis) in transportation; C3 Energy, Opower, and SolarCity in power; Hampton Creek Foods and Kaiima in agriculture; and Cree, DIRTT, and Nest Labs in buildings. As we show in our book, these companies have the potential to upend traditional competitors and create previously unimagined business models. For examples of what this might look like at scale, see the sidebar, "Twelve companies of tomorrow."

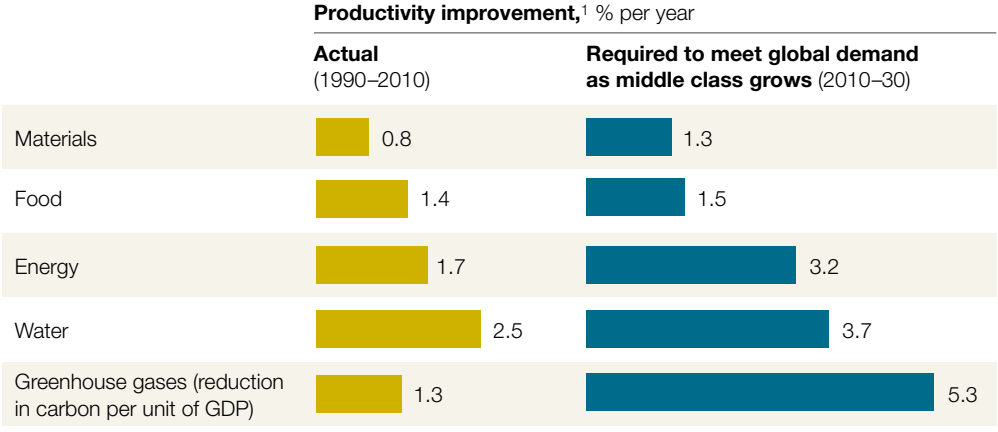
Substitution

The guiding principle for substitution is to consider every resource a company uses in its core products and every resource customers use or consume and then to look for higher-performing and less expensive, less risky, or less scarce materials that might work as substitutes. But don't think of the new resources as replacements for the current bill of materials. Look instead at how substitution

[1]Our McKinsey colleagues Hanh Nguyen and Martin Stuchtey, along with McKinsey alumnus Markus Zils, discuss the circularity approach in "Remaking the industrial economy," *McKinsey Quarterly*, February 2014, on mckinsey.com.

Exhibit

A step-change improvement in resource productivity is required to sustain GDP growth.



[1] Productivity improvement in energy measured in GDP/Btu (British thermal unit); materials, GDP/metric ton; water, GDP/cubic meter; food, yield/hectare; and greenhouse gases, GDP/ton of carbon-dioxide equivalent.

Source: *Resource Revolution: Meeting the world's energy, materials, food, and water needs*, McKinsey Global Institute report, 2011

might deliver superior overall performance, much as electric motors are more efficient and provide better safety and acceleration than traditional internal-combustion ones. Carbon fiber, for instance, not only saves weight but allows companies to build quieter, better-performing, more efficient, more comfortable, and more beautiful cars (Tesla) or airplanes (Boeing's Dreamliner).

These opportunities are extraordinary because many new materials have begun to reshape industrial and consumer products. A much richer understanding of materials science at the nanoscale level, combined with advanced computer-processing power, has catalyzed a broad revolution in surface properties, absorption characteristics, and optical and electrical properties.

For example, activated carbon, typically made of nanoparticles with custom-engineered pore sizes, is dramatically improving the efficiency of water filters, electrodes in batteries, and potentially even power-plant exhaust scrubbers. For the first time since the development of leaded crystal, centuries ago, glass is being reinvented—

from high-bandwidth optical-networking fiber to Corning's Gorilla Glass, which allows touch screens to capture the imagination in portable devices and, soon, on larger interactive screens. A company called View is even creating "dynamic glass," which changes its visible- and infrared-light transmission characteristics so that windows can be programmed to block the sun on hot days but to capture sunlight in the depths of winter. That would reduce the need for heating and air-conditioning in Mediterranean climates, where cool nights mix with hot days.

Substitution extends even to food production. Hampton Creek Foods, for instance, has developed a plant-based egg substitute for baked and processed foods. Called Beyond Eggs, it uses peas, sorghum, beans, and other plants to make a product that tastes like eggs and has the same nutritional properties. The company says its process is already nearly 20 percent less expensive than the production of eggs, and costs will fall as scale increases. Hampton Creek also says its product will suffer less from drought. At the moment, about 70 percent of an egg's cost comes from corn, a crop susceptible to drought and increasingly linked to the price of oil, while Hampton Creek uses hardier crops and therefore does not compete with biofuels (or risk salmonella infections). So, Hampton Creek's egg substitute may cut costs and risks for major food producers.

Spotting substitution opportunities takes hard work. Apple and GE have gone through the periodic table element by element, assessing which ones pose the biggest risks for supply, costs, and regulation. These companies have developed substitution opportunities for each risky element. Similarly, we recently completed a review for a major oil company, looking at the resource risk in its supply chain, and found that the lack of available water would probably cut its growth sharply below expectations over the next decade. Looking a decade ahead gives companies a time advantage over competitors in responding to potential constraints.

Optimization

Another way for companies to boost the productivity of existing resources is to optimize their use—for instance, by integrating software into traditional industrial equipment or providing heavy equipment as a service, something most businesses can do at every level of activity.

GE, for example, outfits its jet engines with advanced software and sensors that yield important real-time maintenance data midflight. As a result, planes can radio ahead with spare parts and servicing requirements before they land. GE often prices its maintenance per hour of flight, so anticipating and streamlining maintenance activities is critical to business profitability.

Komatsu, the industrial-equipment manufacturer, goes even further, optimizing the use of its equipment essentially by creating a market that lets customers rent to and from each other. Need a $300,000 earth mover for just a few days? Komatsu will help find one that would otherwise be sitting idle. Have unused equipment? Komatsu will help find a company to rent it.

Some methods of optimization are surprisingly straightforward. UPS reduced fuel consumption and improved safety and speed by rerouting its trucks to avoid left turns. We helped a large utility shave 30 percent off its meter-reading costs just by restructuring service routes to reflect new traffic conditions and customer-use patterns. And the US Air Force is optimizing fuel consumption by having some of its planes fly in convoys. The new patterns, which copy the way geese "vortex surf" in V-formation, saves up to 20 percent on fuel—a huge amount for one of the world's largest fuel consumers. Implementing the new configuration was not expensive. Maintaining the precise separations between planes required nothing more than changing a few lines of code in the autopilot. Pilots also needed some training not to override it manually.

As companies consider which opportunities have the most potential, the guiding principles should be these: What expensive assets could be integrated with software and sensors? Which pieces of equipment are used only for a small portion of the time? What energy-intensive equipment is active without performing a function? This could be construction equipment, shipping containers that go back empty, or simply planes circling airports waiting for congestion to clear. All lend themselves to IT solutions that optimize routing, timing, loading, or sharing.

Virtualization

As a thought experiment, create a list of physical objects or products that you no longer own or use, even though they were an everyday

part of your life just five or ten years ago. For many people, that list might well include traditional calculators, paper calendars, cameras, alarm clocks, or photo albums. All of these have been rendered virtual by smartphone technology.

Virtualization means moving activities out of the physical world or simply not doing things, because they've been automated—and both challenge business models. Companies struggle to embrace virtualization because they don't want people to stop doing things that generate revenue, which always seems to drop more than costs do when activities move into the virtual realm. Look at newspapers, which get from a digital ad just 16 percent of the revenues they got from a comparable print ad.

Likewise, car companies don't want people to drive less, but that's what's happening in developed countries. Miles driven per capita peaked in 2004 in the United States and have declined steadily since. The reasons aren't entirely clear yet: the decline started before the recent recession and has continued even as the economy rebounded. Higher gas prices are surely a factor, but probably more important is the fact that many people are doing things virtually that they used to do by hopping into cars. For example, the recent holiday shopping season demonstrated how much Americans now rely on online purchases. Even US teenagers have shown a declining interest in driving, according to statistics on the age when Americans get their first license (the ability to connect via social media being a possible reason). Skype and other video-chat applications further reduce the need to drive somewhere to see someone. Work, too, is becoming more virtual as people increasingly use online media and virtual private networks to connect productively without needing an office. Virtualization will happen whether companies want it or not, so they need to prepare themselves.

Nest Labs, a start-up purchased by Google, has already shown what's possible. The company took a traditional, boring, analog piece of equipment—the thermostat—and turned it into a digital platform that provides dynamic energy and security services (and could one day deliver entertainment, health-care, security, and communication services to homes). Several years ago, it would have been hard to imagine ordinary alarm clocks going virtual.

What's next? Could everyday items like eyeglasses, keys, money, and wallets soon disappear in the same way? Do cars and trucks need drivers? Should drones deliver packages? Can IBM's Watson and other expert systems provide better and safer maintenance advice in industrial settings?

The integration challenge

Making the most of any of these models represents a huge change to the way companies operate, organize, and behave. The influence of big technological changes, among them the rise of big data and the Internet of Things,[2] guarantees that for most companies, the biggest initial challenge will be systems integration: embedding software in traditional industrial equipment. Building and running these systems represents one of the biggest managerial challenges of the 21st century.

Going far beyond the current networks of phones, roads, and the like, the most complicated and powerful network yet is now being built. In it, devices embedded in power lines, household appliances, industrial equipment, and vehicles will increasingly talk to one another without the need for any human involvement. For example, by the end of the decade, cars will communicate directly with each other about speeds, direction, and road conditions.

The reach of these integration capabilities will go far beyond infrastructure and manufacturing. Today, for example, clinicians diagnose depression through a lengthy assessment. But simply matching call patterns and GPS signals on a phone to determine whether someone has become a hermit is a more accurate diagnostic approach, not to mention a better early-warning signal.[3] To make the most of such opportunities, health-care companies must figure out how to integrate systems far beyond the hospital.

Systems integration has been a discipline for a long time, but, frankly, most companies aren't very good at it. This is especially true in

[2]Markus Löffler and Andreas Tschiesner, "The Internet of Things and the future of manufacturing," June 2013, mckinsey.com.

[3]Devon Brewer, Tracy Heibeck, David Lazer, and Alex Pentland, "Using reality mining to improve public health and medicine," Robert Wood Johnson Foundation, February 2009.

resource-intensive areas where technologies have been in place for decades or longer (the electric transformer outside your house, for example, was invented in the 1880s). One reason is that the problems are intrinsically hard, often involving billions more data permutations and combinations. Systems integration is more like trying to manage an ever-evolving ecosystem than solving the sort of finance problem one encounters in business school.

Despite the challenges, companies can do three things to increase the odds of success greatly: create simple software building blocks, expand frontline analytical talent, and apply computational-modeling techniques whenever possible—then test, test, test to learn and refine.

Recognize the scope

Simply realizing that systems are subtle and that lots of variables are interacting simultaneously will give any company a head start. Starting with a few simple software building blocks lays the foundation for success. The case of US power distribution is instructive.

The build-out of the US electric grid has been called the 20th century's greatest engineering achievement, but the grid's basic technology has changed little since the time of Edison and Westinghouse. The average circuit is 40 years old, and some have been around for more than a century. The grid is showing its age.

This translates into declining reliability and increasing costs and risks for utilities and their customers. The average utility generally learns about problems with its power lines when customers call

in to complain rather than by receiving information on the problems directly. Issues at substations often have to be addressed by sending maintenance workers into the field to flip a switch, not by having someone in a central control room make the change—or, better yet, having the grid sense the problem and either fix it automatically or route electricity around it.

Utilities have to overcome their own inefficiencies and adapt to the rapidly shifting contemporary environment. Homeowners, for instance, are putting solar panels on their roofs, depriving utilities of many of their most profitable customers. Utilities will now have to figure out how to integrate into the grid the power these homes sometimes make available.

Once electric vehicles are deployed in large numbers, utilities will have to get used to the power equivalent of a commercial building unplugging, moving, and plugging back in somewhere else. Utilities must develop capabilities for integrating—in real time—not only what they are doing but also what all the related interconnected players are doing.

The era of big data will also have a huge effect. At the moment, the average utility collects about 60 million data points each year—five million customers and a dozen monthly bills. When smart meters, distributed generation, and electric vehicles come into widespread use, the average utility may have to handle five billion data points each *day*. The grid will almost need to be redesigned from scratch to get the full benefit of the new types of solid-state transformers, as well as the ability to sense problems and solve them automatically and, essentially, to have little power plants on millions of rooftops as solar prices keep coming down.

Expand frontline analytical capabilities

Mastering the building blocks of the resource revolution will also require intelligent organizational design and excellent talent management. In some cases, the specialized knowledge and know-how won't be at hand, because companies are dealing with new problems, but each manager will need to find any expertise available. Software skills, specialized engineering, nanotechnology, and ultralow-cost manufacturing are just four of the many areas where

talent will be scarce. In some instances, it will make sense for companies to form partnerships with businesses in other industries to gain access to specialized expertise.

In other cases, companies will have to develop new management skills from scratch. Some of the need will occur at the top of organizations, among leaders. The leadership skills required to deliver 10 to 15 percent annual productivity gains for a decade or more are a far cry from the incremental-improvement skills that marked the generation of leaders after World War II. Business-model innovation will no longer be just for start-ups or technology companies.

Frontline workers too will have to learn how to use massive amounts of analytical data to perform heavy industrial tasks. These frontline workers will need to be educated, whether by schools, the government, or employers, to undertake this technical work. For example, resource productivity requires frontline gas-leak detection teams to make sophisticated decisions based on big data and advanced analytics, leveraging technology to find and fix leaks rather than just walking the block with the technological equivalent of a divining rod. Many traditional frontline workers need a knowledge worker's skills, such as the ability to analyze data, evaluate statistics, identify the root causes of problems, set parameters on machines, update algorithms, and collaborate globally.

The good news is that while the search for new organizational models and new talent in new places will be extraordinarily taxing, just about all of the competition will face the same problems. The sooner management starts confronting the gaps a company is facing, the sooner it is likely to close them—and gain an edge on the ones that don't.

Model, then test

Because systems are so complex, the only way to know for sure whether a process works is to test it. But, these days, a company can do an awful lot of that testing through computer models. For instance, the US national labs—notably Lawrence Livermore, Los Alamos, and Sandia—have maintained the nation's nuclear capabilities without testing live warheads for decades, by using advanced computational methods. Now companies can deploy these same techniques to accelerate product development. One defense contractor used computer modeling to test thousands of potential new materials at

the atomic level to find a few superlight, high-performance, and very reliable composites for next-generation jet engines. The best manufacturers of batteries can test their performance for thousands of hours, across an extremely broad range of operating conditions, in the Argonne National Laboratory battery-testing facility outside Chicago, dramatically accelerating product innovation.

For example, when ATMI, a materials-technology company, went looking for a better way to extract gold from electronic waste than traditional smelting methods or baths of toxic acids, it resorted to computational modeling of combinatorial chemistries. The resulting eVOLV process uses a water-based solution that's safe to drink and is dramatically cheaper than the traditional methods. Moreover, the process allows the collected computer chips to be reused, since they are never exposed to high temperatures or acids (the toxic solder is collected as a by-product). The equipment can even be placed on a truck for processing e-waste at collection sites. This is what we mean when we say a resource revolution will open up solutions that are not only cheaper and more efficient but also better.

The resource revolution represents the biggest business opportunity in a century. However, success requires new approaches to management. Companies that try to stick to the old "2 percent solution" (just improve performance by 2 percent annually and you will be fine) are going to become obsolete quickly. Businesses that can deliver dramatic resource-productivity improvements at scale will become the great companies of the 21st century.

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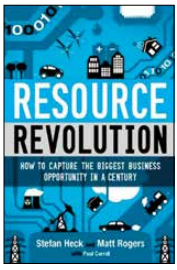


This article is based in part on the authors' book, *Resource Revolution: How to Capture the Biggest Business Opportunity in a Century* (New Harvest, April 2014).

Twelve companies of tomorrow

1 **Maximum Oil Recovery Enterprise (MORE)** companies would get more oil from wells. They would use advanced sensor networks and operating techniques to recover 60 to 70 percent of the oil in every field, up from the traditional 20 to 30 percent—reducing risk and the need to drill in remote, difficult areas.

2 **Efficient Resilient Grid Operator (ERGO)** businesses would capitalize on the shift from an analog, hub-and-spoke power grid to an integrated digital network. The new grid would connect many distributed-power generators. It would also incorporate storage so power can be generated at more efficient times, rerouted to handle shortages, and flow in both directions. Digital transformers sharply reduce power losses in transit.

3 **HOme Unified SErvices (HOUSE)** firms would reach into homes more completely than security, utility, and media companies do today, using data from mobile devices to provide services enhancing comfort and convenience. For example, this technology would not only anticipate and recognize your preferences for lighting, temperature, health services, news, education, and music but also use them as you move from place to place.

4 **Convenient Organizer Service for Travel (COST)** companies would efficiently handle travel details, such as rides, rooms, and tickets to events. COST companies would optimize routing and inventory—users would type in where and when they wanted to go and COST handles the rest, choosing among shared, electric, or autonomous cars, trains, and planes.

5 **Global Recovery of Waste (GROW)** companies would be the most profitable miners, using microfluidic technologies to recover high-value products in waste streams: gold and silver from consumer electronics, lithium from geothermal effluent, and high-value rare-earth metals from electronics, for instance. GROW miners would also provide heat, power, and fertilizer from organic waste.

6 **WAter DElight (WADE)** firms would use nonchemical-purification techniques and mineralization technologies to provide high-quality water for agriculture and the world's best drinking water. Through partnerships that reduced waste, increased recycling, and provided networkwide leak detection and management in cities, such businesses would ensure that water systems needed new water for only 20 percent of their total annual requirement. The health benefits from expanded fresh-water access would more than pay for the infrastructure.

While we possess no crystal ball, we can imagine the next 20 years giving rise to global companies that exploit the new resource-productivity fundamentals and look different from today's leaders. Here are 12 possibilities:

7 **Fresh Organic Opportunities Delivered (FOOD)** companies would be global, integrated organizations that locally produced high-quality, nutritious food using one-tenth of the water and energy of existing methods.

8 **Lightweight Innovation Technology Engineering (LITE)** enterprises would make carbon fiber cheaper than aluminum. Cars, trucks, ships, planes, and buildings will become safer and more efficient (and more pleasing, aerodynamic, and comfortable). Additive manufacturing allows for the quick replacement of parts anywhere. Carbon-fiber recycling helps close the loop and promotes a "circular economy."

9 **Government Operations Verified (GOV)** firms would be low-cost service providers that let governments use standardized technology platforms to deliver personalized services—for example, passports and drivers' licenses, health and retirement plans, and tailored career training and advice. Many private companies would deliver efficient, innovative services over the GOV platforms, like apps on mobile platforms today.

10 **SEnsor Network SOlutions (SENSO)** companies would give businesses trillion-point, integrated sensor networks and access to a marketplace of algorithmic analyses of sensor data. Much as Google search terms created a new field of research, these companies would give small ones access to big data and the tools to make business decisions using it.

11 **Equipment as Service for You (EASY)** enterprises would expand the experience many companies have with software as a service by developing businesses based on equipment as a service, but on a larger scale than today's rental companies. Small businesses could get access to the most advanced heavy equipment, with remote-operations capabilities to handle high-value local requirements.

12 **Basics All Supplied in Container (BASIC)** firms would serve emerging markets and offer companies access to some of the least advantaged people in these regions by delivering essential infrastructure in rugged containers. This infrastructure might include solar power, electrical storage, cell-phone towers, phone charging and service, water pumping and purification, LED lamps, and Internet access (with dedicated channels for information and services). BASIC firms would bring low-cost energy, water, and communications to the next billion consumers in developing markets.

Fred Krupp on the benefits of monitoring resource use

The head of the Environmental Defense Fund describes how the rise of big data and sensing technologies could improve the bottom line for companies and the environment.

Ten years ago, a lot of business executives realized that environmental concerns were real business challenges. But mostly, they were protecting themselves against downside reputational risks. Today, an increasing number of businesses have figured out there's not only the downside to be protected against, but there's tremendous upside profits to be made by serving a market that's increasingly interested in green goods and services. And costs can be dramatically slashed when companies operate in a way that's more efficient.

Ten years from now, what I see is an Internet-connected world where the behaviors of companies—including how products have been produced—are so transparent that those businesses who are truly good citizens will be rewarded in the marketplace. And those companies that haven't paid a lot of attention, and maybe are operating in some ways that are sloppy—or even wrong—well, they won't be able to PR-spin their way out of it. The ability of citizens to see what's actually happening is very powerful.

The revolution in big data and sensing technologies will be very important in using resources more efficiently because it lets companies know what's happening with their inputs. So not only can a company such as GE monitor the efficiency of its jet engines, but anyone who operates car or truck fleets can monitor—and optimize—fuel efficiency.

In the farms around the United States, it's becoming possible to monitor how much fertilizer is being wasted and just running off with the rainwater. This allows us to optimize crop yields—important for farmers and consumers—as well as fertilizer use, which would help us minimize the "dead zone"[1] that develops at the bottom of the Mississippi River and in the Gulf of Mexico.

Meanwhile, the World Resources Institute has launched a website[2] that monitors deforestation by using millions of bits of data that are produced every minute from satellites circling the planet. This will be very important to make sure our forests aren't being wasted. And as it becomes possible for individual citizens and citizen groups to use monitoring and sensing technology to monitor air pollution in real time, the transparency in the data will drive pollution levels down.

Ultimately, what gets measured gets managed, and there are examples of problems where better measurement would help a lot. One area is natural gas. Right now, the system is leaking natural gas into the atmosphere, the industry doesn't have good, regular measurements of how much methane is escaping, and methane is a very potent greenhouse-gas warmer. By requiring companies to do regular leak-detection and -repair programs, we can keep natural gas in the pipes, use it more efficiently, and stop one big source of global warming. Similarly, shale gas is a bounty for the United States and has helped the US economy without a doubt—but the environmental downsides of shale production are equally obvious. We need to learn how to extract this resource in ways that protect citizens living near the wells and the atmosphere.

People ask if I'm optimistic. I say instead that I'm hopeful. Optimism is a prediction that everything's going to end well. Hope is a verb with its sleeves rolled up. I am hopeful that there are enough positive trends happening that if we work at it, and apply ourselves, we can solve these problems.

[1] The "dead zone," or hypoxic zone, refers to the area in a body of water that lacks sufficient levels of oxygen to support marine life.

[2] For more, visit the Global Forest Watch's site, www.globalforestwatch.org.

Fred Krupp is the president of the Environmental Defense Fund. This commentary is adapted from an interview with **Rik Kirkland,** senior managing editor of McKinsey Publishing, who is based in McKinsey's New York office.

Daniel Yergin on the next energy revolution

The global energy expert and Pulitzer Prize–winning author expects an energy landscape rife with innovations—and surprises.

The unconventional-oil and -gas revolution—shale gas and what's become known as "tight oil"—is the most important energy innovation so far in the 21st century. I say *so far*, because we can be confident that there will be other innovations coming down the road. There's more emphasis on energy innovation than ever before. Unconventional oil and gas came as a pretty big surprise. It even took the oil and gas industry by surprise. "Peak oil" was such a fervent view five or six years ago, when oil prices were going up.

But I looked at this the way I did in *The Quest*,[1] which was: Yes, we've gone through this period of running out of oil, but we've gone through at least five previous episodes of running out of oil. Each time, what's made the difference? New technology, new knowledge, new territories. And something else that people forget: price. When we look at economic history, we see a very powerful lesson that has to be learned and relearned: price matters a lot. Price encourages consumers to be more efficient. It encourages the development of new technologies and new ways of doing things. Indeed, I think that the impact of price is often underestimated as the stimulator of innovation and creativity.

There are a number of big initiatives and opportunities that could bring changes. Certainly, the electric car will continue to be a big push, as it's captured the imagination of some people, and a lot of investment has gone into it. Also, public policy is pushing it hard.

[1]Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World*, second edition, New York, NY: Penguin, 2012.

I think it's going to take a few more years to get a sense of the uptake, though, because electric cars are competing not with the automobiles of yesterday but with the more fuel-efficient cars of tomorrow. Another big area is electricity storage. If there's a holy grail out there these days, it's storage, because innovations in electricity storage would change the economics of wind and solar power.

Distributed electricity generation will increasingly be a big question for developed countries. Electricity won't just be generated in large, central plants, but through wind power on hillsides and through solar power generated on lots and lots of rooftops. These developments make things much more complicated for the people who have the responsibility for managing the stability of the grid. They also raise important questions about incentives and subsidies that need to be worked out, such as who pays to support the grid? These will be the subject of much debate and turmoil over the next several years as we get our arms around a whole new set of issues.

I don't know what the pathway's going to be to solve the problems. But when you have a lot of bright people working on a problem in a sustained way, you will probably get to a solution. Will it be 5 years or 15 years? We don't know but, ultimately, need drives innovation. I see this as all part of the great revolution that began with the steam engine, and there's no reason to think it's going to end. It's going to continue in the oil and gas industry, and it's also going to stimulate innovations of other kinds among renewables and alternatives.

We're not always going to be able to predict where the innovations will happen. Not by any means. But this great revolution in human civilization around energy innovation is going to continue as far as we can see—indeed, much further than we can see. Of course, history tells us that geopolitics can come along and deliver some shocking surprises, but surprises are one of the key characteristics of energy over the long term. One thing we can be sure of: there are always more surprises to come.

Daniel Yergin is the vice-chairman of IHS, the research and data company, and author of the Pulitzer Prize–winning book *The Prize: The Epic Quest for Oil, Money & Power* (Simon & Schuster, 1991). This commentary is adapted from an interview with **Rik Kirkland,** senior managing editor of McKinsey Publishing, who is based in McKinsey's New York office.

The disruptive potential of solar power

David Frankel, Kenneth Ostrowski, and Dickon Pinner

As costs fall, the importance of solar power to senior executives is rising.

The economics of solar power are improving. It is a far more cost-competitive power source today than it was in the mid-2000s, when installations and manufacturing were taking off, subsidies were generous, and investors were piling in. Consumption continued rising even as the MAC Global Solar Energy Index fell by 50 percent between 2011 and the end of 2013, a period when dozens of solar companies went bankrupt, shut down, or changed hands at fire-sale prices.

The bottom line: the financial crisis, cheap natural gas, subsidy cuts by cash-strapped governments, and a flood of imports from Chinese solar-panel manufacturers have profoundly challenged the industry's short-term performance. But they haven't undermined its potential; indeed, global installations have continued to rise—by over 50 percent a year, on average, since 2006. The industry is poised to assume a bigger role in global energy markets; as it evolves, its impact on businesses and consumers will be significant and widespread. Utilities will probably be the first, but far from the only, major sector to feel solar's disruptive potential.

Economic fundamentals

Sharply declining costs are the key to this potential. The price US residential consumers pay to install rooftop solar PV (photovoltaic) systems has plummeted from nearly $7 per watt peak of best-in-class system capacity in 2008 to $4 or less in 2013.[1] Most of this decline has been

[1]Based on the 90th percentile of 2012–13 installed costs in California, as reported to the California Solar Initiative.

the result of steep reductions in upstream (or "hard") costs, chiefly equipment. Module costs, for example, fell by nearly 30 percent a year between 2008 and 2013, while cumulative installations soared from 1.7 gigawatts in 2009 to an estimated 11 gigawatts by the end of 2013, according to GTM Research.

While module costs should continue to fall, even bigger opportunities lurk in the downstream (or "soft") costs associated with installation and service. Financing, customer acquisition, regulatory incentives, and approvals collectively represent about half the expense of installing residential systems in the United States. Our research suggests that as they become cheaper, the overall costs to consumers are poised to fall to $2.30 by 2015 and to $1.60 by 2020.

These cost reductions will put solar within striking distance, in economic terms, of new construction for traditional power-generation technologies, such as coal, natural gas, and nuclear energy. That's true not just for residential and commercial segments, where it is already cost competitive in many (though not all) geographies, but also, eventually, for industrial and wholesale markets. Exhibit 1 highlights the progress solar already has made toward "grid parity" in the residential segment and the remaining market opportunities as it comes further down the curve. China is investing serious money in renewables. Japan's government is seeking to replace a significant portion of its nuclear capacity with solar in the wake of the Fukushima nuclear accident. And in the United States and Europe, solar adoption rates have more than quadrupled since 2009.

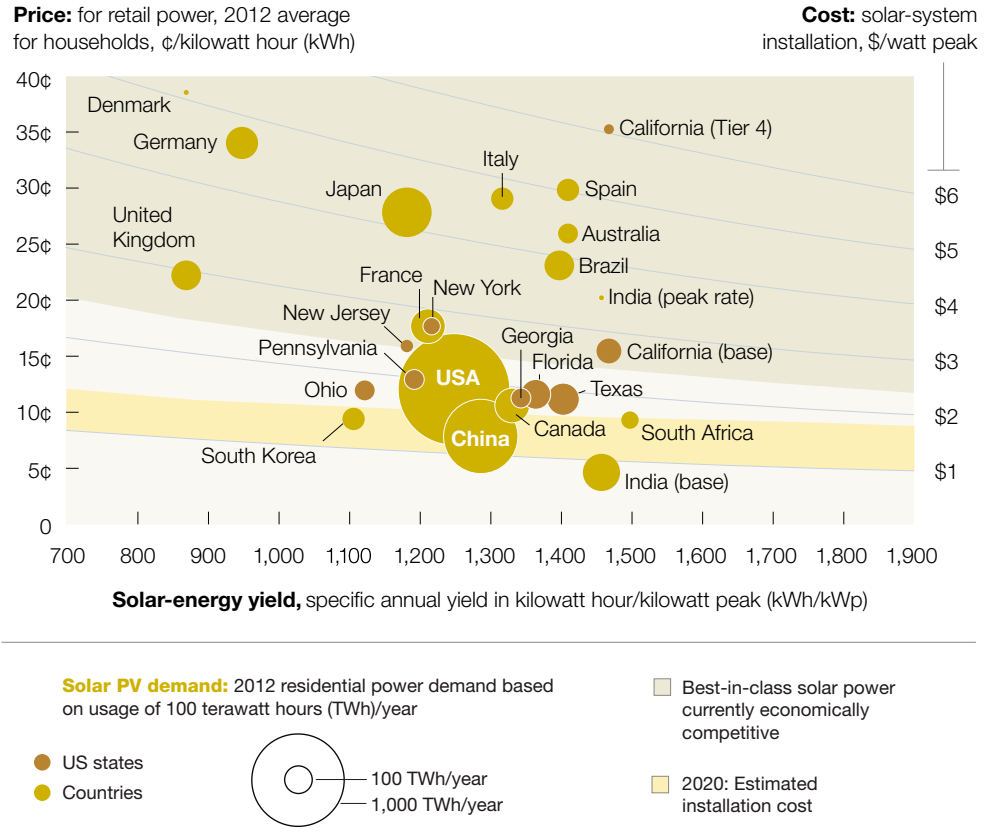
While these economic powerhouses represent the biggest prizes, they aren't the only stories. Sun-drenched Saudi Arabia, for example, now considers solar sufficiently attractive to install substantial capacity by 2032,[2] with an eye toward creating local jobs. And in Africa and India, where electric grids are patchy and unreliable, distributed generation is increasingly replacing diesel and electrifying areas previously without power. Economic fundamentals (and in some cases, such as Saudi Arabia, the desire to create local jobs) are creating a brighter future for solar.

[2]Both solar PV and concentrated solar power (CSP) are included in the Saudi government's request for proposals.

Exhibit 1

A sharp decline in installation costs for solar photovoltaic systems has boosted the competitiveness of solar power.

Grid-parity potential of solar PV (photovoltaic) power in major markets, residential-segment example[1]



[1] For methodology and sources, see Exhibit 1 in the online version of this article, on mckinsey.com.

Business consumption and investment

Solar's changing economics are already influencing business consumption and investment. In consumption, a number of companies with large physical footprints and high power costs are installing commercial-scale rooftop solar systems, often at less than the current price of buying power from a utility. For example, Wal-Mart Stores has stated that it will switch to 100 percent renewable power by 2020, up from around 20 percent today. Mining and defense companies are looking to solar in remote and demanding environments. In the hospitality sector, Starwood Hotels and

Resorts has partnered with NRG Solar to begin installing solar at its hotels. Verizon is spending $100 million on solar and fuel-cell technology to power its facilities and cell-network infrastructure. Why are companies doing such things? To diversify their energy supply, save money, and appeal to consumers. These steps are preliminary, but if they work, solar initiatives could scale up fast.

As for investment, solar's long-term contracts and relative insulation from fuel-price fluctuations are proving increasingly attractive. The cost of capital also is falling. Institutional investors, insurance companies, and major banks are becoming more comfortable with the risks (such as weather uncertainty and the reliability of components) associated with long-term ownership of solar assets. Accordingly, investors are more and more willing to underwrite long-term debt positions for solar, often at costs of capital lower than those of traditional project finance.

Major players also are creating advanced financial products to meet solar's investment profile. The best example of this to date is NRG Yield, and we expect other companies to unveil similar securities that pool renewable operating assets into packages for investors. Google has been an active tax-equity investor in renewable projects, deploying more than $1 billion since 2010. It also will be interesting to track the emergence of solar projects financed online via crowdsourcing (the best example is Solar Mosaic, which brings investors and solar-energy projects together). This approach could widen the pool of investors while reducing the cost of capital for smaller installations, in particular.

Disruptive potential

The utility sector represents a fascinating example of the potential for significant disruption as costs fall, even as solar's scale remains relatively small. Although solar accounts for only less than half a percent of US electricity generation, the business model for utilities depends not so much on the current generation base as on installations of new capacity. Solar could seriously threaten the latter because its growth undermines the utilities' ability to count on capturing all new demand, which historically has fueled a large share of annual revenue growth. (Price increases have accounted for the rest.)

Depending on the market, new solar installations could now account for up to half of new consumption (in the first ten months of 2013, more than 20 percent of new US installed capacity was solar). By altering the demand side of the equation, solar directly affects the amount of new capital that utilities can deploy at their predetermined return on equity. In effect, though solar will continue to generate a small share of the overall US energy supply, it could well have an outsized effect on the economics of utilities—and therefore on the industry's structure and future (Exhibit 2).

That's already happening in Europe. Over the last several years, the demand for power has fallen while the supply of renewables (including solar) has risen, driven down power prices, and depressed the penetration of conventional power sources. US utilities can learn many lessons from their European counterparts, which for the most part stood by while smaller, more nimble players led the way. Each US utility will have to manage the risks of solar differently. All of them, however, will have to do something.

Broader management implications

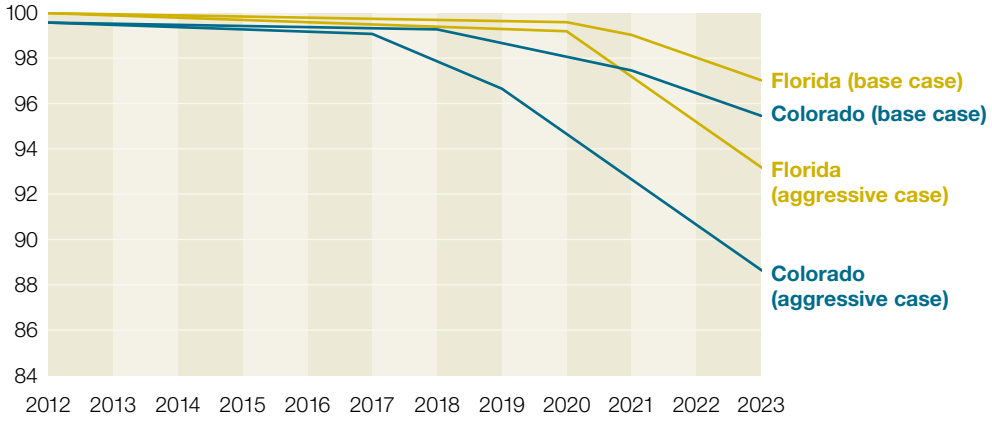
As solar becomes more economic, it will create new battlegrounds for business and new opportunities for consumers. When a solar panel goes up on a homeowner's roof, the installer instantly develops a potentially sticky relationship with that customer. Since the solar installation often puts money in the homeowner's pocket from day one, it is a relationship that can generate goodwill. But, most important, since solar panels are long-lived assets, often with power-purchase agreements lasting 15 or 20 years, the relationship also should be enduring.

That combination may make solar installers natural focal points for the provision of many products and services, from security systems to mortgages to data storage, thermostats, smoke detectors, energy-information services, and other in-home products. As a result, companies in a wide range of industries may benefit from innovative partnerships built on the deep customer relationships that solar players are likely to own. Tesla Motors already has a relationship with SolarCity, for example, to develop battery storage coupled with solar. It is easy to imagine future relationships between many other complementary players. These possibilities suggest a broader point: the solar story is no longer just about

Exhibit 2

Although solar power will continue to account for a small share of the overall US energy supply, it could well have an outsize effect on the economics of utilities.

Remaining electricity consumption from utilities after solar PV (photovoltaic) adoption, both residential and commercial,[1] % of megawatt hours (MWh)



[1] For methodology and sources, see Exhibit 2 in the online version of this article, on mckinsey.com.

technology and regulation. Rather, business-model innovation and strong management practices will play an increasingly important role in the sector's evolution and in the way it engages with a range of players from other industries. Segmenting customers, refining pricing strategies, driving down costs, and optimizing channel relationships all will figure prominently in the solar-energy ecosystem, as they do elsewhere.

As solar becomes integrated with energy-efficiency solutions, data analytics, and other technologies (such as storage), it will become an increasingly important element in the next generation of resource-related services and of the world's coming resource revolution. In the not too distant future, a growing number of industries will have to take note of the promise, and sometimes the threat, of solar to business models based on traditional energy economics. But, in the meantime, the battle for the customer is taking place today, with long-term ramifications for existing industry structures.

The authors would like to thank Stefan Heck, Sean Kane, and Farah Mandich for their contributions to this article.

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Change leader, change thyself

Nate Boaz and Erica Ariel Fox

Anyone who pulls the organization in new directions must look inward as well as outward.

Illustration by Daniel Bejar

Leo Tolstoy, the Russian novelist, famously wrote, "Everyone thinks of changing the world, but no one thinks of changing himself."

Tolstoy's dictum is a useful starting point for any executive engaged in organizational change. After years of collaborating in efforts to advance the practice of leadership and cultural transformation, we've become convinced that organizational change is inseparable from individual change. Simply put, change efforts often falter because individuals overlook the need to make fundamental changes in themselves.[1]

Building self-understanding and then translating it into an organizational context is easier said than done, and getting started is often the hardest part. We hope this article helps leaders who are ready to try and will intrigue those curious to learn more.

Organizations don't change—people do

Many companies move quickly from setting their performance objectives to implementing a suite of change initiatives. Be it a new growth strategy or business-unit structure, the integration of a recent acquisition or the rollout of a new operational-improvement effort, such organizations focus on altering systems and structures and on creating new policies and processes.

[1]For a case study of leadership development supporting organizational change, see Aaron De Smet, Johanne Lavoie, and Elizabeth Schwartz Hioe, "Developing better change leaders," *McKinsey Quarterly*, April 2012, mckinsey.com.

To achieve collective change over time, actions like these are necessary but seldom sufficient. A new strategy will fall short of its potential if it fails to address the underlying mind-sets and capabilities of the people who will execute it.

McKinsey research and client experience suggest that half of all efforts to transform organizational performance fail either because senior managers don't act as role models for change or because people in the organization defend the status quo.[2] In other words, despite the stated change goals, people on the ground tend to behave as they did before. Equally, the same McKinsey research indicates that if companies can identify and address pervasive mind-sets at the outset, they are four times more likely to succeed in organizational-change efforts than are companies that overlook this stage.

Look both inward and outward

Companies that only look outward in the process of organizational change—marginalizing individual learning and adaptation—tend to make two common mistakes.

The first is to focus solely on business outcomes. That means these companies direct their attention to what Alexander Grashow, Ronald Heifetz, and Marty Linsky call the "technical" aspects of a new solution, while failing to appreciate what they call "the adaptive work" people must do to implement it.[3]

The second common mistake, made even by companies that recognize the need for new learning, is to focus too much on developing skills. Training that only emphasizes new behavior rarely translates into profoundly different performance outside the classroom.

In our work together with organizations undertaking leadership and cultural transformations, we've found that the best way to achieve an organization's aspirations is to combine efforts that look outward

[2]For more on McKinsey's organizational-health index and findings on organizational change, see Scott Keller and Colin Price, "Organizational health: The ultimate competitive advantage," *McKinsey Quarterly*, June 2011, mckinsey.com.

[3]Alexander Grashow, Ronald Heifetz, and Marty Linsky, *The Practice of Adaptive Leadership: Tools and Tactics for Changing Your Organization and World*, Boston, MA: Harvard Business Review Publishing, 2009.

with those that look inward. Linking strategic and systemic intervention to genuine self-discovery and self-development by leaders is a far better path to embracing the vision of the organization and to realizing its business goals.

What is looking inward?

Looking inward is a way to examine your own modes of operating to learn what makes you tick. Individuals have their own inner lives, populated by their beliefs, priorities, aspirations, values, and fears. These interior elements vary from one person to the next, directing people to take different actions.

Interestingly, many people aren't aware that the choices they make are extensions of the reality that operates in their hearts and minds. Indeed, you can live your whole life without understanding the inner dynamics that drive what you do and say. Yet it's crucial that those who seek to lead powerfully and effectively look at their internal experiences, precisely because they direct how you take action, whether you know it or not. Taking accountability as a leader today includes understanding your motivations and other inner drives.

For the purposes of this article, we focus on two dimensions of looking inward that lead to self-understanding: developing profile awareness and developing state awareness.

Profile awareness

An individual's profile is a combination of his or her habits of thought, emotions, hopes, and behavior in various circumstances. Profile awareness is therefore a recognition of these common tendencies and the impact they have on others.

We often observe a rudimentary level of profile awareness with the executives we advise. They use labels as a shorthand to describe their profile, telling us, "I'm an overachiever" or "I'm a control freak." Others recognize emotional patterns, like "I always fear the worst," or limiting beliefs, such as "you can't trust anyone." Other executives we've counseled divide their identity in half. They end up with a

simple liking for their "good" Dr. Jekyll side and a dislike of their "bad" Mr. Hyde.

Finding ways to describe the common internal tendencies that drive behavior is a good start. We now know, however, that successful leaders develop profile awareness at a broader and deeper level.

State awareness

State awareness, meanwhile, is the recognition of what's driving you at the moment you take action. In common parlance, people use the phrase "state of mind" to describe this, but we're using "state" to refer to more than the thoughts in your mind. State awareness involves the real-time perception of a wide range of inner experiences and their impact on your behavior. These include your current mind-set and beliefs, fears and hopes, desires and defenses, and impulses to take action.

State awareness is harder to master than profile awareness. While many senior executives recognize their tendency to exhibit negative behavior under pressure, they often don't realize they're exhibiting that behavior until well after they've started to do so. At that point, the damage is already done.

We believe that in the future, the best leaders will demonstrate both profile awareness and state awareness. These capacities can develop into the ability to shift one's inner state in real time. That leads to changing behavior when you can still affect the outcome, instead of looking back later with regret. It also means not overreacting to events because they are reminiscent of something in the past or evocative of something that might occur in the future.[4]

Close the performance gap

When learning to look inward in the process of organizational transformation, individuals accelerate the pace and depth of change dramatically. In the words of one executive we know, who has

[4]For an in-depth exploration of the adult development involved as leaders mature, see Robert Kegan and Lisa Laskow Lahey, *Immunity to Change: How to Overcome It and Unlock the Potential in Yourself and Your Organization*, Boston, MA: Harvard Business Review Publishing, 2009.

invested heavily in developing these skills, this kind of learning "expands your capacity to lead human change and deliver true impact by awakening the full leader within you." In practical terms, individuals learn to align what they intend with what they actually say and do to influence others.

Erica Ariel Fox's recent book, *Winning from Within*,[5] calls this phenomenon closing your performance gap. That gap is the disparity between what people *know* they should say and do to behave successfully and what they *actually* do in the moment. The performance gap can affect anyone at any time, from the CEO to a summer intern.

This performance gap arises in individuals partly because of the profile that defines them and that they use to define themselves. In the West in particular, various assessments tell you your "type," essentially the psychological clothing you wear to present yourself to the world.

To help managers and employees understand each other, many corporate-education tools use simplified typing systems to describe each party's makeup. These tests often classify people relatively quickly, and in easily remembered ways: team members might be red or blue, green or yellow, for example.

There are benefits in this approach, but in our experience it does not go far enough and those using it should understand its limitations. We *all* possess the full range of qualities these assessments identify. We are not one thing or the other: we are all at once, to varying degrees. As renowned brain researcher Dr. Daniel Siegel explains, "we must accept our multiplicity, the fact that we can show up quite differently in our athletic, intellectual, sexual, spiritual—or many other—states. A heterogeneous collection of states is completely normal in us humans."[6] Putting the same point more poetically, Walt Whitman famously wrote, "I am large, I contain multitudes."

To close performance gaps, and thereby build your individual leadership capacity, you need a more nuanced approach that recognizes your inner complexity. Coming to terms with your full richness is

[5] Erica Ariel Fox, *Winning from Within: A Breakthrough Method for Leading, Living, and Lasting Change*, New York, NY: HarperBusiness, 2013.

[6] Daniel Siegel, *Mindsight: The New Science of Personal Transformation*, New York, NY: Bantam Books, 2010.

challenging. But the kinds of issues involved—which are highly personal and well beyond the scope of this short management article—include:

- What are the primary parts of my profile, and how are they balanced against each other?
- What resources and capabilities does each part of my profile possess? What strengths and liabilities do those involve?
- When do I tend to call on each member of my inner executive team? What are the benefits and costs of those choices?
- Do I draw on all of the inner sources of power available to me, or do I favor one or two most of the time?
- How can I develop the sweet spots that are currently outside of my active range?

Answering these questions starts with developing profile awareness.

Leading yourself—and the organization

Individuals can improve themselves in many ways and hence drive more effective organizational change. We focus here on a critical few that we've found to increase leadership capacity and to have a lasting organizational impact.

1. Develop profile awareness: Map the Big Four

While we all have myriad aspects to our inner lives, in our experience it's best to focus your reflections on a manageable few as you seek to understand what's driving you at different times. Fox's *Winning from Within* suggests that you can move beyond labels such as "perfectionist" without drowning in unwieldy complexity, by concentrating on your Big Four, which largely govern the way individuals function every day. You can think of your Big Four as an inner leadership team, occupying an internal executive suite: the chief executive officer (CEO), or inspirational Dreamer; the chief financial officer (CFO), or analytical Thinker; the chief people officer (CPO), or emotional Lover; and the chief operating officer (COO), or practical Warrior (exhibit).

How do these work in practice? Consider the experience of Geoff McDonough, the transformational CEO of Sobi, an emerging pioneer in the treatment of rare diseases. Many credit McDonough's versatile leadership with successfully integrating two legacy companies and increasing market capitalization from nearly $600 million in 2011 to $3.5 billion today.

From our perspective, his leadership success owes much to his high level of profile awareness. He also displays high profile agility: his skill at calling on the right inner executive at the right time for the right purpose. In other words, he deploys each of his Big Four intentionally and effectively to harness its specific strengths and skills to meet a situation.

McDonough used his inner Dreamer's imagination to envision the clinical and business impact of Sobi's biological-development program in neonatology. He saw the possibility of improving the neurodevelopment of tiny, vulnerable newborns and thus of giving them a real chance at a healthy life.

His inner Thinker's assessment took an unusual perspective at the time. Others didn't share his evaluation of the viability of integrating

Exhibit

Executives can achieve self-understanding, without drowning in unwieldy complexity, by concentrating on the Big Four of their 'inner team.'

Inner negotiator	Focus of attention	Power source	Sweet spot
Inspirational Dreamer (CEO)	• What I want • What I don't want	Intuition	• Generate your vision • Dare to pursue your dream • Sense a path forward
Analytical Thinker (CFO)	• My opinion • My ideas	Reason	• Apply facts and logic • Consider consequences • Look from all sides
Emotional Lover (CPO, or chief people officer)	• How we both feel • Our level of trust	Emotion	• Connect with emotions • Build and maintain trust • Collaborate with others
Practical Warrior (COO)	• What task to do • What line to draw	Willpower	• Speak hard truths • Hold your ground • Take action

Source: Erica Ariel Fox, *Winning from Within: A Breakthrough Method for Leading, Living, and Lasting Change*, New York, NY: HarperBusiness, 2013

one company's 35-year legacy of biologics development (Kabi Vitrum—the combined group of Swedish pharmaceutical companies Kabi and Vitrum—which merged with Pharmacia and was later acquired, forming Biovitrum in 2001) with another's 25-year history of commercializing treatments for rare diseases (Swedish Orphan), to lead in a rare-disease market environment with very few independent midsize companies.

Rising to a separate, if related, challenge, McDonough called on his inner Lover to build bridges between the siloed legacy companies. He focused on the people who mattered most to everyone—the patients—and promoted internal talent from both sides, demonstrating his belief that everyone, whatever his or her previous corporate affiliation, could be part of the new "one Sobi."

Finally, bringing Sobi to its current levels of success required McDonough to tell hard truths and take some painful steps. He called on his inner Warrior to move swiftly, adding key players from the outside to the management team, restructuring the organization, and resolutely promoting an entirely new business model.

2. Develop state awareness: The work of your inner lookout

Profile awareness, as we've said, is only the first part of what it takes to look inward when driving organizational change. The next part is state awareness.

Leading yourself means being in tune with what's happening on the inside, not later but right now. Think about it. People who don't notice that they are becoming annoyed, judgmental, or defensive in the moment are not making real choices about how to behave. We all need an inner "lookout"—a part of us that notices our inner state—much as all parents are at the ready to watch for threats of harm to their young children.[7]

For example, a senior executive leading a large-scale transformation remarked that he would like to spend 15 minutes kicking off an important training event for change agents to signal its importance.

[7] The internal-lookout concept is explored in detail in *Winning from Within*, particularly in chapter nine, pages 241–67.

Objectively speaking, he would probably have the opposite of the intended effect if he said how important the workshop was and then left 15 minutes into it.

What he needed at that moment was the perception of his inner lookout. That perspective would see that he was torn between wanting to endorse the program, on the one hand, and wanting to attend to something else that was also important, on the other. With that clarity, he could make a choice that was sensible and aligned: he might still speak for 15 minutes and then let people know that he wished he could stay longer but had a crucial meeting elsewhere. Equally, he might realize the negative implications of his early departure under any circumstances, decide to postpone the later meeting, and stay another couple of hours. Either way, the inner lookout's view would lead to more effective leadership behavior.

During a period of organizational change, it's critical that senior executives collectively adopt the lookout role for the organization as a whole. Yet they often can't, because they're wearing rose-tinted glasses that blur the limitations of their leadership style, mask destructive mind-sets at lower levels of the organization, and generally distort what's going on outside the executive suite. Until we and others confronted one manager we know with the evidence, he had no idea he was interfering with, and undermining, employees through the excessively large number of e-mails he was sending on a daily basis.

Spotting misaligned perceptions requires putting the spotlight on observable behavior and getting enough data to unearth the core issues. Note that traditional satisfaction or employee-engagement surveys—and even 360-degree feedback—often fail to get to the bottom of the problem. A McKinsey diagnostic that reached deep into the workforce—aggregating the responses of 52,240 individuals at 44 companies—demonstrated perception gaps across job levels at 70 percent of the participating organizations. In about two-thirds of them, the top teams were more positive about their own leadership skills than was the rest of the organization. Odds are, in other words, that rigorous organizational introspection will be eye opening for senior leaders.

3. Translate awareness into organizational change

Those open eyes will be better able to spot obstacles to organizational change. Consider the experience of a company that became aware, during a major earnings-improvement effort, that an absence of coaching was stifling progress. On the surface, people said they did not have the time to make coaching a priority. But an investigation of the root causes showed that one reason people weren't coaching was that they themselves had become successful despite never having been coached. In fact, coaching was associated with serious development needs and seen only as a tool for documenting and firing people. Beneath the surface, managers feared that if they coached someone, others would view that person as a poor performer.

Changing a pervasive element of corporate culture like this depends on a diverse set of interventions that will appeal to different parts of individuals and of the organization. In this case, what followed was a positive internal-communication campaign, achieved with the help of posters positioning star football players alongside their coaches and supported by commentary spelling out the impact of coaching on operating performance at other organizations. At the same time, executives put "the elephant in the room" and acknowledged the negative connotations of coaching, and these confessions helped managers understand and adapt such critical norms. In the end, the actions the executives initiated served to increase the frequency and quality of coaching, with the result that the company was able to move more rapidly toward achieving its performance goals.

4. Start with one change catalyst

While dealing with resistance and fear is often necessary, it's rarely enough to take an organization to the next level. To go further and initiate collective change, organizations must unleash the full potential of individuals. One person or a small group of trailblazers can provide that catalyst.

For many years, it was widely believed that human beings could not run a mile in less than four minutes. Throughout the 1940s and early 1950s, many runners came close to the four-minute mark, but all fell short. On May 6th, 1954, in Oxford, England, Roger Bannister ran a mile in three minutes and 59 seconds. Only 46 days after Bannister's historic run, John Landy broke the record again. By 1957, 16 more runners had broken through what once was thought to be

an impossible barrier. Today, well over a thousand people have run a mile in less than four minutes, including high-school athletes.

Organizations behave in a similar manner. We often find widely held "four-minute mile" equivalents, like "unattainable growth goals" or "unachievable cost savings" or "unviable strategic changes." Before the broader organization can start believing that the impossible is possible, one person or a small number of people must embrace a new perspective and set out to disprove the old way of thinking. Bannister, studying to be a doctor, had to overcome physiologists' claims and popular assumptions that anyone who tried to run faster than 15 miles an hour would die.

Learning to lead yourself requires you to question some core assumptions too, about yourself and the way things work. Like Joseph Campbell's famous "hero's journey," that often means leaving your everyday environment, or going outside your comfort zone, to experience trials and adventures.[8] One global company sent its senior leaders to places as far afield as the heart of Communist China and the beaches of Normandy with a view to challenging their internal assumptions about the company's operating model. The fresh perspectives these leaders gained helped shape their internal values and leadership behavior, allowing them to cascade the lessons through the organization upon their return.

This integration of looking both inward and outward is the most powerful formula we know for creating long-term, high-impact organizational change.

[8] For more on Joseph Campbell, visit the Joseph Campbell Foundation's website, jcf.org.

Nate Boaz would like to thank Mobius Executive Leadership for the ongoing collaboration that contributed to these insights. Erica Ariel Fox would like to thank her colleague John Abbruzzese, a senior leadership consultant at Mobius Executive Leadership, for his contribution to this article.

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LEADER-
DRIVEN
KNOWLEDGE-
BASED

The hidden value of organizational health—and how to capture it

Aaron De Smet, Bill Schaninger, and Matthew Smith

New research suggests that the performance payoff from organizational health is unexpectedly large and that companies have four distinct "recipes" for achieving it.

The problem

Building a healthy organization is difficult. "One off" reorganization initiatives often bring only ephemeral benefits. Attempts to close every benchmark and best-practice gap also end in disappointment.

Why it matters

Sustained organizational health is among the most powerful assets a company can build. Healthy companies generate total returns to shareholders three times higher than those of unhealthy ones.

What to do about it

Companies that consistently outperform their peers typically follow one of four distinct organizational "recipes," each characterized by a distinct set of management practices. Leaders should identify the one that most closely matches their strategic aspirations. The trick then is to be truly great in a handful of practices rather than trying to master them all, while avoiding "recipe killers."

Illustration by Andrew Baker

For the past decade, we've been conducting research, writing, and working with companies on the topic of organizational health. Our work indicates that the health of an organization is based on the ability to align around a clear vision, strategy, and culture; to execute with excellence; and to renew the organization's focus over time by responding to market trends. Health also has a hard edge: indeed, we've come to define it as the capacity to deliver—*over the long term*—superior financial and operating performance.

In previous articles and books, such as *Beyond Performance*,[1] we (and others) have shown that when companies manage with an equal eye to performance and health, they more than double the probability of outperforming their competitors. Our latest research, at more than 800 organizations around the world, revealed several new twists:

- We found that the linkage between health and performance, at both the corporate and subunit level, is much clearer and much larger than we had previously thought. With the benefit of more data and a finer lens, we discovered that from 2003 (when we began collecting data on health) to 2011, healthy companies generated total returns to shareholders (TRS) three times higher than those of unhealthy ones.

- We further discovered that companies consistently outperforming their peers generally followed one of four distinct organizational "recipes." We had already recognized these patterns but hadn't understood their strong correlation with health, operational success, and financial performance.

- We also uncovered a practical alternative to the common (but too often disappointing) approach of seeking to improve corporate health by closing every benchmark and best-practice gap. More tailored initiatives that combine efforts to stamp out "broken" practices while building signature strengths not only are more realistic but also increase the probability of building a healthy organization by a factor of five to ten.

[1]Scott Keller and Colin Price, *Beyond Performance: How Great Organizations Build Ultimate Competitive Advantage*, first edition, Hoboken, NJ: John Wiley & Sons, 2011. See also Scott Keller and Colin Price, "Organizational health: The ultimate competitive advantage," *McKinsey Quarterly*, June 2011, mckinsey.com.

In short, we're more convinced than ever that sustained organizational health is one of the most powerful assets a company can build. We're also clearer on how to achieve it, including the pitfalls to avoid on the road. We hope this is welcome news to leaders worried about the long term, who frequently complain to us that the benefits of their one-off reorganization initiatives are ephemeral.[2]

How we track health

For the past ten years, we have measured and tracked organizational health in hundreds of companies, business units, and factories around the world. We ask employees (more than 1.5 million and counting) about their perceptions of the health of their organizations and what management practices they do or don't see in them. We then produce a single health score, or index, reflecting the extent to which employees say that their organizations are "great" in each of nine dimensions (or outcomes) of organizational health. To establish more precisely what each organization looks like, as well as its strengths and weaknesses, we also ask employees how frequently they observe[3] four to five specific management practices—how managers run the place—that drive those nine outcomes. Exhibit 1 provides some flavor of how the management practices, 37 in all, line up against the outcomes.

When we have done this with similar units—such as factories, processing units, and regions—in a given company, we have frequently found a strong correlation between organizational health (as measured by our survey) and the unit's financial or operating performance.

For example, when we established health scores at 16 refineries in the same energy group, we noted a sharp linear relationship between those scores and each refinery's performance as defined by gross profit per unit of output. Health explained 54 percent of the variation in the units' profits.

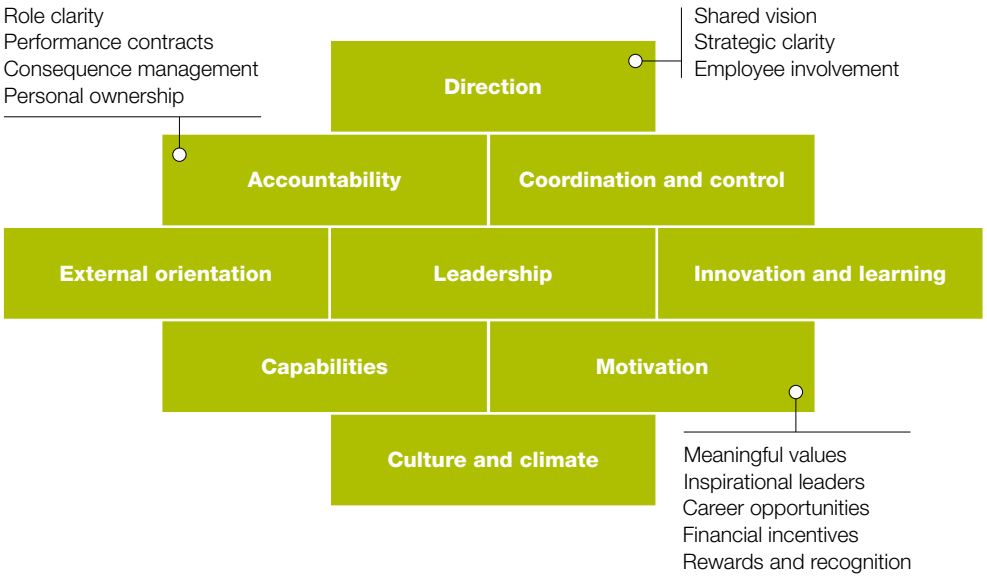
[2]These were the fortunate ones. Our global survey shows that only one-third achieve change goals.

[3]On a scale ranging from "never or almost never" to "always or almost always."

Exhibit 1

The organizational-health index tracks nine dimensions of organizational health, along with their related management practices.

In all, the index covers 37 related management practices. Here are selected examples of practices for 3 of the dimensions.



In the insurance industry, we found similar results when we compared 11 claims-processing sites. In this case, we found a strong correlation between health (as defined by the site-specific summary score) and performance (defined as a carrier's specific proprietary amalgamated metric across indemnity, expense, and customer-satisfaction metrics). Health differences explained about one-third of the variation in performance.[4] This is a significant number, since the remaining two-thirds includes known determinants of performance, such as competition, macroeconomic forces, and local-market dynamics (we did not evaluate the relative importance of these forces, which, unlike organizational health, leaders cannot control).

After replicating these findings across many clients and industries, we began to wonder about the strength of the health effect. Could health possibly explain performance variations across companies, industries, and geographies?

[4]The explanatory power rose to 56 percent when a single outlier was removed.

When we compared the health metrics of more than 270 publicly traded companies[5] with their financial-performance metrics, we found that the healthiest generated total returns to shareholders that were three times higher than those of companies in the bottom quartile and over 60 percent higher than those of companies with "middle of the road" health profiles. We have not yet isolated the specific health effect for the sample as a whole, but judged by the energy and insurance-company examples, it is likely to be substantial.

Management practices matter

The most interesting findings, though, came when we looked more closely at the healthiest organizations in our database. Obviously, all had high health scores as measured by the nine outcomes of health. But when we delved deeper and looked at the 37 practices that management teams focus on to deliver those outcomes, we discovered that four combinations of practices, or "recipes," were associated with sustained success. Indeed, further analysis showed that companies strongly aligned with any of these four organizational recipes were five times more likely to be healthy and to deliver strong, sustained performance than companies with mixed (or random) recipes.

Each of the four clusters we identified from the data reflects a distinct underlying approach to managing, including core beliefs about value creation and what drives organizational success. Each can be described by the specific set of management practices prioritized by companies that follow it (Exhibit 2).

The hallmark of the first, or *leader-driven*, recipe is the presence, at all of an organization's levels, of talented, high-potential leaders who are set free to figure out how to deliver results and are held accountable for doing so. This open, trusting culture is typical of highly decentralized organizations or of new businesses, where the resolve of strong leaders, effectively multiplied by their peers across the organization, is essential to create something from nothing. While most organizations use career opportunities to

[5]The full database includes many nonpublic companies and government organizations that were excluded for this analysis.

motivate employees, companies in this cluster use career opportunities as a leadership-development practice. Role modeling and real experience are more important than passing along sage lessons.

Organizations following the second, or *market-focused*, recipe tend to have a strong external orientation toward not only customers but also competitors, business partners, regulators, and the community. These companies strive to be product innovators, shape market trends, and build a portfolio of solid, innovative brands to stay ahead of the competition. The best ones both respond to demand and develop products that help shape it (a strong recent example would be Apple as it reshaped several consumer-technology markets). They have a shared vision and the strategic clarity to ensure that employees explore the right market opportunities, as well as strong financial management to provide individual accountability and to ensure that responses to market trends are in fact profitable.

Exhibit 2

Each of the four clusters identified from the data reflects a distinct organizational approach and can be described by a specific set of management practices.

Top 5 out of 37 management practices prioritized by companies that follow given approach

Leader driven	Market focused	Execution edge	Talent and knowledge core
Career opportunities	Customer focus	Knowledge sharing	Rewards and recognition
Inspirational leaders	Competitor insights	Employee involvement	Talent acquisition
Open and trusting	Business partnerships	Creative and entrepreneurial	Financial incentives
Financial incentives	Financial management	Bottom-up innovation	Career opportunities
Risk management	Government/community relationships	Talent development	Personal ownership

The third recipe, which we call *execution edge*, includes companies that stress continuous improvement on the front line, allowing them to raise quality and productivity constantly while eliminating waste and inefficiency. These companies place a heavy emphasis on sharing knowledge across employees and sites—not just as a way to foster innovation, but, paradoxically, also as the primary way to drive standardization. Knowledge sharing helps to manage the frequent trade-offs between the top-down need for networkwide consistency and bottom-up encouragement of employees; without it, the best ideas might not get disseminated across different units of an organization. Such companies are unlike market-focused ones, which push alignment and consistency more strongly from the top down by analyzing external trends and developing a clear strategy for where the market is going.

The fourth and final recipe, *talent and knowledge core*, is found frequently among successful professional-services firms, professional sports teams, and entertainment businesses. Such organizations emphasize building competitive advantage by assembling and managing a high-quality talent and knowledge base. They typically focus on creating the right mix of financial and nonfinancial incentives to acquire the best talent and then on motivating their employees and giving them opportunities. In contrast to companies in the leader-driven group (whose value is created through teams directed by a strong leader), talent and knowledge-core organizations succeed thanks to highly skilled individual performers.

Implementing a healthy recipe

The case of a global chemical manufacturer we know highlights the power of the recipe approach. This company faced increasing energy costs, intensifying international competition, stricter environmental regulation, and the shutdown of one of its sites in an environmental-permit dispute. It had to move quickly to reduce its costs, improve its maintenance productivity, and raise production.

This company's mining operation had approximately 450 employees distributed in an area more than five times the size of Manhattan. A health-feedback session where the voice of the organization was "mirrored" back to it showed clearly that the appropriate recipe was

execution edge. After an action-planning workshop, executives developed interventions to encourage the most important practices for this recipe: knowledge sharing, employee involvement, and a creative and entrepreneurial environment. Efforts were made to redefine the role of frontline supervisors (including retraining), to engage the frontline workforce, and to step up the impact of employee communication. These initiatives led to greater employee involvement in decisions and more bottom-up knowledge sharing.

For example, the company introduced regular one-on-one visits between miners and supervisors to discuss productivity strategies, to review progress meeting production targets, and to engage in "micromine planning." Supervisors became the bottom-up conduit for cross-fertilizing these ideas in daily shift-production meetings, weekly "step back" meetings, and monthly management meetings.

Other miners and supervisors, motivated no doubt by the continuing emphasis on accountability for production, voluntarily adopted the best solutions. Not unexpectedly, the miners and supervisors began to feel greater ownership of their work, and employee engagement increased by 20 percent.

As for the operational-performance goals, wrench time[6] increased to 45 percent, from a baseline of 22 percent. Productivity, in turn, rose by 50 percent over a two-year period, generating additional profits of $350 million. Costs fell sharply, with annual run-rate savings of approximately $180 million.

It is worthwhile noting that the transformation blended health objectives with performance goals. Neither was treated in isolation. One reinforced the other, making each immediately relevant and maximizing the likelihood that the organization will sustain performance and respond successfully if challenged again by severe market disruption.

[6]An indicator of maintenance performance: a measure of the amount of time that craft personnel spend actually carrying out their primary tasks (for instance, using tools to make a repair), as opposed to time spent traveling from project to project or sitting in meetings.

Building a healthier organization

What can be learned from the four healthy organizational clusters our latest research identified? How can companies adapt accordingly? We certainly wouldn't suggest that they blindly seek to replicate one of the cluster recipes, ingredient by ingredient or practice by practice. Just as great chefs don't copy and paste the recipes of others, companies must take these general archetypes as inspiration and identify the pattern of healthy practices that best fits their own organizations and strategies. In the continuing search for a better-functioning organization, companies should consider the following issues.

The imperative of alignment between strategy and health

Successful companies match their organizations to their aspirations. Once a company has identified the most appropriate organizational recipe for the chosen strategy, it should align the organization as far as possible with that mix of practices. If its most important day-to-day practices do not support its strategy, or are not consistent with the direction communicated by its leadership, the misalignment can often undermine both overall performance and health.

Such misalignments often happen in strategic shifts. A large technology company we know changed its product and service mix and rapidly accelerated its globalization strategy. It then realized that what it really needed was a new focus on developing high-potential leaders who could direct next-generation businesses and operate with a global mind-set. Such moves would bring the

company closer to the leader-driven recipe. Its old execution focus was no longer a powerful competitive weapon.

This company developed what it called "critical paths" for a ladder of opportunities available to high-potential leaders. These paths culminated in an important role, such as general manager for a large region, and promoted to prominence leaders who were visibly inspirational. When the company's own research showed that trust accounted for 90 percent of its employees' perceptions of how effective their managers were, it focused its development efforts accordingly. (Coincidentally, trust was one of its three core cultural values.)

The company ultimately avoided the "commodity hell" it feared. It reliably increases its margins every year, leads its industry in segments where it elects to compete, and is recognized by respected analysts as a leading "talent factory."

The importance of selection

Our earlier research had already shown that to be in the top group of healthy organizations, companies must do better than bottom-quartile ones across the full suite of 37 management practices. But a better-than-bottom score is generally enough for practices that are not essential to a company's recipe. The trick is to be truly great in a handful of practices—and not to worry a lot about the rest, which is just as well because no company has the capacity, resources, or management time to be great at all 37. The power of the four recipes our research unearthed is that they provide an indication of where to concentrate improvement efforts.

We discovered that 73 percent of the companies that strongly or very strongly follow one of the four recipes, *and* are not in the bottom quartile for any practice, enjoy top-quartile health. By contrast, only 7 percent of companies that have at least one broken practice *and* a less-than-strong embrace of any of the recipes are in the top quartile. Taken together, this represents a better than 10:1 ratio of effectiveness. It also suggests that the right course is to fix all broken practices (by improving them enough so that a company escapes the bottom quartile) and to turn a targeted handful of practices into true strengths. Trying to exceed the median benchmark on a large number of practices is not effective.

The danger of recipe killers

Our research also identified recipe killers—the management equivalent of baking a beautiful chocolate soufflé but then adding too much salt and rendering the dish inedible. The new data suggest that, just as concentrating on too many practices diminishes an organization's odds of achieving top health and success, adding the wrong practices to the recipe can be extremely harmful.

One example is the overemphasis on command-and-control leadership styles in companies trying to follow the execution-edge recipe. Most people think execution requires that approach. Actually, execution requires tremendous on-the-ground energy, so the best execution-driven organizations employ internal competition and bottom-up innovation to empower the front line to excel. Overuse of top-down processes would kill that dynamic—and, indeed, in our data set the least healthy execution-edge organizations are those that have the authoritative-leadership practice in their top ten.

• • •

Building organizational health can be a powerful lever for improving the long-term performance of companies. Leaders can't ignore this lever, given the accelerating pace of change facing most industries.

Companies can achieve organizational health in several ways—the four key ones we have discussed here. But gratifying simplicity masks hidden risks. Choose your recipes and ingredients carefully, as the wrong mix may leave a bad taste in the mouths of employees, executives, and investors alike.

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The future of lean

After 50 years of lean production, you might think that this venerable management discipline had reached its limits. You'd be wrong.

Next frontiers for lean

Ewan Duncan and Ron Ritter

Lean-production techniques have been revolutionizing operations for 50 years. Advances in technology, psychology, and analytics may make the next 50 even more exciting.

When the first issue of *McKinsey Quarterly* rolled off the printing presses, 50 years ago, nearly everyone in senior management thought that manufacturing operations had been perfected. Henry Ford's great innovation, the moving assembly line, had been refined over the previous five decades, had served as the arsenal of democracy during World War II, and by the mid-1960s was operating efficiently, at great scale, in a wide range of industries around the world.

Quietly, though, in Nagoya, Japan, Taiichi Ohno and his engineering colleagues at Toyota were perfecting what they came to call the Toyota production system, which we now know as lean production. Initially, lean was best known in the West by its tools: for example, *kaizen* workshops, where frontline workers solve knotty problems; *kanban*, the scheduling system for just-in-time production; and the *andon* cord, which, when pulled by any worker, causes a production line to stop. In more recent years, this early (and often superficial) understanding of lean has evolved into a richer appreciation of the power of its underlying management disciplines: putting customers first by truly understanding what they need and then delivering it efficiently; enabling workers to contribute to their fullest potential; constantly searching for better ways of working; and giving meaning to work by connecting a company's strategy and goals in a clear, coherent way across the organization.

Lean is one of the biggest management ideas of the past 50 years. No less than Ford's original assembly line, it has transformed how leading companies think about operations—starting in assembly plants and other factory settings and moving more recently into services ranging from retailing and health care to financial services, IT, and even the public sector. Yet despite lean's trajectory, broad influence, and level of general familiarity among senior executives, it would be a mistake to think that it has reached its full potential.

Indeed, in this article and those that follow, we'll argue that as senior executives gain more exposure to lean and deepen their understanding of its principles and disciplines, they will seek to drive even more value from it. The opportunities available to them are considerable. For example, powerful new data sources are becoming available, along with analytical tools that make ever more sophisticated frontline problem solving possible; see "When big data goes lean," on page 97. Similarly, leading-edge companies are discovering that lean can supply powerful insights about the next frontiers of energy efficiency; see "Bringing lean thinking to energy," on page 103. Toyota itself is pushing the boundaries of lean, rethinking the art of the possible in production-line changeovers, for example, and bringing customer input more directly into factories; see "(Still) learning from Toyota," on page 106. And leading service-based companies such as Amazon.com are extending the value of lean further still, into areas beyond manufacturing; see "When Toyota met e-commerce: Lean at Amazon," on page 90.

What's more, new technologies, new analytical tools, and new ways of looking at customers are making it possible, with greater precision than ever before, to learn what they truly value. The implications are profound because one of the primary constraints on the ability to design a perfect lean system in any operating environment has always been the challenge of understanding customer value, lean's ultimate "north star." In this article, we'll highlight the advances that could make it possible to translate what customers value into additional improvements and help to bridge the age-old gaps among operations, marketing, and product development—groups that have historically occupied separate silos.

When lean met services

The present round of improvements won't be the first time lean has catalyzed management innovation by bringing together what seemed to be strange bedfellows. The first time around, lean operating principles were applied to service industries that had not previously thought of themselves as having factory-like characteristics. Consider these examples from the *Quarterly* during lean's early forays into services:

Retail banking

Since it involves a physical process not unlike an assembly line, the handling of paper checks and credit-card slips lends itself readily to lean-manufacturing techniques. And their impact can be dramatic: the faster a bank moves checks through its system, the sooner it can collect its funds and the better its returns on invested capital.

Devereaux A. Clifford, Anthony R. Goland, and John Hall, "First National Toyota," *McKinsey Quarterly*, November 1998, mckinsey.com.

Hospitals

Obviously, a hospital isn't an automobile factory, and people—especially sick ones—are less predictable than car parts. Nevertheless, hospitals, which usually have far fewer discrete stages to worry about than do major manufacturers, can often reduce their variability a good deal.

Paul D. Mango and Louis A. Shapiro, "Hospitals get serious about operations," *McKinsey Quarterly*, May 2001, mckinsey.com.

Airlines

Aircraft worth $100 million or more routinely sit idle at gates. Turnaround times between flights typically vary by upward of 30 percent. Lean techniques cut hours to minutes with a [new] changeover system. . . .

Stephen J. Doig, Adam Howard, and Ronald C. Ritter, "The hidden value in airline operations," *McKinsey Quarterly*, November 2003, mckinsey.com.

Eliminating delays

Minutes and seconds per step for Airbus A320 single-aisle medium-range airliner (disguised example)

	Turnaround time between flights			
	Average	Best practice	**Potential reduction**[1]	**Lean techniques**
Unload passengers[2]	6:14	4:38	1:36	Stricter controls on carry-on bags, fewer passengers moving back in aisle to find bag
Wait for cleaning crew to board aircraft	0:24	0:18	0:06	Cleaning crew in position ahead of time
Clean airplane	11:48	9:40	2:08	Standardized work flow, timing, and methods, such as cleaning supplies in prearranged kits
Wait for transmission to gate of cabin crew's approval to board	4:11	0	4:11	Visual signal from cabin crew to agent when plane is ready to board—for example, light flashing at top of ramp
Wait for first passenger to board	4:06	0	4:06	
Load passengers	19:32	16:00	3:32	Active management of overhead storage bins by flight attendants
Wait for passenger-information list	1:58	0:13	1:45	Passenger-information list delivered by agent following last passenger to board
Close aircraft door	0:57	0:09	0:48	Agent ready at aircraft to close door
Detach boarding ramp	1:39	0:43	0:56	
Total time (including initial steps[2])	**52:18**	**33:11**	**19:07**	

[1]Assumes rudimentary application of lean techniques; further reductions may be possible.
[2]Time for initial steps (attaching boarding ramp, opening aircraft door, and waiting for first passenger to deplane) can't be significantly reduced.

Restaurants

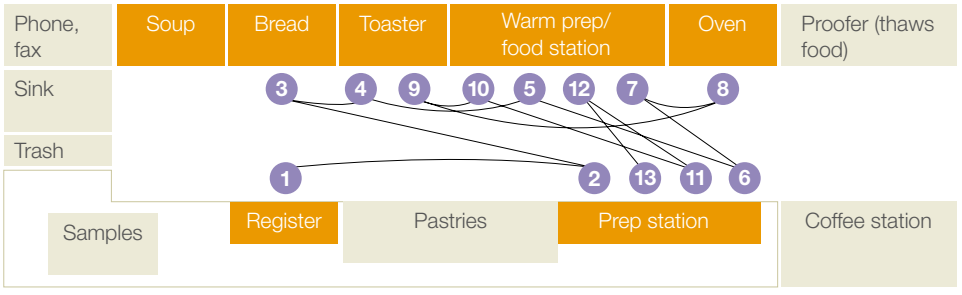
Lean techniques seek to improve product and service quality while simultaneously reducing waste and labor costs. For food-service operators, the additional trick is to link such improvements to customer loyalty.

John R. McPherson and Adrian V. Mitchell, "Lean cuisine," *McKinsey Quarterly*, February 2005, mckinsey.com.

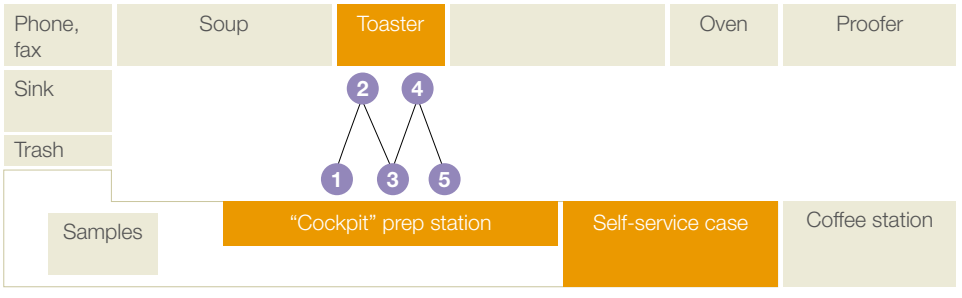
Standardizing procedures saves time.

Service steps for fulfilling order (example: hot chicken sandwich)

Before lean improvements



After lean improvements



Reduced preparation time for …

… a breakfast sandwich by **51 seconds**

… a lunch sandwich by **1 minute, 11 seconds**

Asset management

Power companies use 'peaker' plants to manage spikes in electricity demand flexibly and cost-effectively. Likewise, managers in many back-office processing environments can make them more flexible and remove waste to boot by organizing transactions or activities according to their variability and then assigning different ones to baseload or swing teams.

Dan Devroye and Andy Eichfeld, "Taming demand variability in back-office services," *McKinsey Quarterly*, September 2009, mckinsey.com.

New horizons

As these examples suggest, lean is hardly stationary. Indeed, as senior managers' understanding of lean continues to develop, we expect it to further permeate service environments around the world. In the past few years alone, we've observed lean's successful application to mortgage processing in India, customer-experience improvements in a Colombian pension fund, better and faster processing of political-asylum requests in Sweden, and the streamlining of business services in the United Arab Emirates.[1]

In the years ahead, service and product companies alike will increasingly be able to reach their long-term goal of eliminating waste as defined directly by customers across their entire life cycle—or journey—with a company.[2] For example, an unprecedented amount of product-performance data is now available through machine telematics. These small data sensors monitor installed equipment in the field and give companies insights into how and where products are used, how they perform, the conditions they experience, and how and why they break down. A number of aerospace and industrial-equipment companies are starting to tap into this information. They are learning—directly from customer experience with their products—about issues such as the reliability of giant marine engines and mining equipment or the fuel efficiency of highway trucks in different types of weather.

The next step is to link this information back to product design and marketing—for example, by tailoring variations in products to the precise environmental conditions in which customers use them. Savvy companies will use the data to show customers evidence of unmet needs they may not even be aware of and to eliminate product or service capabilities that aren't useful to them.[3] Applying lean techniques to all these new insights arising at the interface of marketing, product development, and operations should enable

[1] To learn more about these and other examples, see *The Lean Management Enterprise: A system for daily progress, meaningful purpose, and lasting value* (January 2014), a collection of articles available at mckinsey.com/leanmanagement.

[2] For more about customer journeys, see Ewan Duncan, Conor Jones, and Alex Rawson, "The truth about customer experience," *Harvard Business Review*, 2013, Volume 91, Number 9, pp. 90–98.

[3] See Ananth Narayanan, Asutosh Padhi, and Jim Williams, "Designing products for value," *McKinsey Quarterly*, October 2012, mckinsey.com.

companies to make new strides in delighting their customers and boosting productivity.

Information about customers won't be coming only from sensors and databases. The understanding of what makes people tick has been improving dramatically, and companies are starting, more and more, to apply psychology to their operations.[4] Disney, for example, recognized that visitors in its theme parks respond to different emotional cues at different times of the day and embedded this realization into its operations in precise ways. In the morning, for example, Disney employees are encouraged to communicate in a more inspirational style, which resonates with eager families just starting out their day at the park. In the late afternoon (when children are tired and nerves become frayed), employees aim for a more calming and supportive style of communication. The integration of these psychological insights with Disney's operating philosophy allows the company to eliminate waste of a different sort: employee behavior that would not be desired by customers and might inadvertently alienate them at certain times of the day.

Finally, market- and consumer-insight tools (for instance, statistically based regression analysis, as well as advanced pricing- and financial-modeling tools) are creating a far more sophisticated (and much closer to real-time) view of what customers value. The changes may just be getting started. Better-integrated data sets across channels and touchpoints are rapidly enabling companies to get much more complete views of all interactions with customers during the journeys they take as they evaluate, buy, consume, and seek support for products and services. Usage patterns of mobile devices and services are painting a richer picture than companies previously enjoyed.

The end result should be more scientific insight into how product and service attributes contribute to customer value; new ways to look at what matters most for classic lean variables, such as lead time, cost, quality, responsiveness, flexibility, and reliability; and

[4] See John DeVine and Keith Gilson, "Using behavioral science to improve the customer experience," *McKinsey Quarterly*, February 2010, mckinsey.com.

new opportunities for cross-functional problem solving to eliminate anything that strays from customer-defined value.

The future of lean is exciting. Its tools for eliminating waste and for increasing value as customers define it are being enhanced by huge gains in the volume and quality of the information companies can gather about customer behavior, the value of the marketing insights that can be integrated with operations, and the sophistication of the psychological insights brought to bear on the customer's needs and desires. These advances bring new meaning to the classic lean maxim "learning to see." The contrast between where companies are now and where they'll be 20 years on will seem as stark as the difference between a static color photograph and a high-definition, three-dimensional video.

The authors wish to thank Jeff James, vice president of the Disney Institute, for his contribution to this article.

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Q50

McKinsey Quarterly began publishing articles on Japanese manufacturing techniques in the 1970s and later explored lean's extension to services with a series of articles starting in the 1990s.

When Toyota met e-commerce: Lean at Amazon

Marc Onetto

Amazon's former head of global operations explains why the company was a natural place to apply lean principles, how they've worked in practice, and where the future could lead.

The spirit of lean management was already at Amazon when I arrived in 2007. Since the day he created Amazon, Jeff Bezos has been totally customer-centric. He knew that customers would not pay for waste—and that focus on waste prevention is a fundamental concept of lean. The company's information technology was always very good at understanding what the customer wanted and passing the right signal down. For example, the selection of the transportation method for a given package is driven, first, by the promised delivery date to the customer. Lower-cost options enter the equation only if they provide an equal probability of on-time delivery. That's basically a lean principle.

As a technology company, Amazon initially had the belief that most issues could be resolved with technology, so it was not systematically engaging frontline workers in a process of continuous improvement. Part of lean is the strong engagement of the front line—with the *gemba* workers—on continuous improvement. Amazon has more people working in the fulfillment centers and customer-service centers than it does computer-science engineers. We needed the engagement of all these people to succeed, since they are the ones who are actually

receiving, stowing, picking, packing, and sending packages or responding to customers by phone, chat, or e-mail.

Earlier in Amazon's development, the company had been trying to automate almost everything in a fulfillment center. The automation was designed for books but did not work for new types of goods, such as shoes, as Amazon expanded its selection. When the shoebox reached the flip mechanism in the automated machine that was supposed to collect the shoes and bring them to the packing line, they went flying out of the box. As a consequence, we were limited to certain types of goods in the automated warehouses.

Given the business evolution of Amazon from a bookstore to the store for everything, we had to reinvent automation, following the lean principle of "autonomation": keep the humans for high-value, complex work and use machines to support those tasks. Humans are extremely creative and flexible. The challenge of course is that sometimes they are tired or angry, and they make mistakes. From a Six Sigma perspective, all humans are considered to be at about a Three Sigma level, meaning that they perform a task with about 93 percent accuracy and 7 percent defects. Autonomation helps human beings perform tasks in a defect-free and safe way by only automating the basic, repetitive, low-value steps in a process. The result is the best of both worlds: a very flexible human being assisted by a machine that brings the process up from Three Sigma to Six Sigma.

Another major dimension of the deployment of lean was the enforcement of "standard work." The problem at many companies, including Amazon, is that workers' assigned tasks are very vague; it's up to the worker to figure things out. So when we started to consider improving our workers' performance, we had to take a detailed look at their assigned tasks. We quickly realized that what was happening in

Gemba

現場 The physical, frontline place of "value work."

Kaizen

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The philosophy of continually improving the products, processes, and activities of a business to meet or exceed changing customer requirements and the organization's standards in an effective and efficient way. Continuous improvement focuses on the elimination of waste or non-value-added activities throughout the organization.

reality was quite different from what was written down—and it was riddled with abnormalities. So we set a very well-defined standard process, tracked all abnormalities, and assigned *kaizen* teams to eliminate them.[1]

I saw this directly when I worked on the stow line in one of the fulfillment centers. Each worker on that line has a trolley full of products and a scanner. The job is to stow the products on the shelves and, at the same time, to scan each item and the corresponding shelf number so the computer knows where the product is located. The standard work-productivity target was 20 minutes per trolley. But when I started to scan products, I realized that I had to scan some things four times before the scanner recognized them. So instead of 20 minutes per trolley, it took me 45. I looked incompetent; I couldn't meet the target. But in fact I was affected by an abnormality: the bad performance of the scanner, which I learned later was due to a low level of charge in its battery.

At the end of the day, we analyzed all the abnormalities reported by the workers. And in my case we looked for the root cause of the scanner issue. How many scans could be completed during the life of the scanner battery? Did we have a process to check and reload the scanner batteries? Frontline managers didn't have any of that information, so there were several hours of low productivity at the end of every scanner's battery charge. That root-cause analysis helped us put a whole process in place to load and monitor our scanners. Now workers will never miss productivity targets because their scanner batteries are low.

[1] Standard work combines the elements of a job into the most effective sequence, without waste, to achieve the most efficient level of production.

Kaizen in the fulfillment center

Kaizen and the whole process of continuous improvement was, and continues to be, a powerful tool at Amazon. That's partly because for a long time Jeff Bezos has had all of senior management work in customer service at least one day a year. This allowed executives to see events on the front line, to understand the problems that came up, and to help find solutions.

Each *kaizen* is a very simple thing, but the accumulation of *kaizens* makes an enormous difference. On one of Bezos's days on the front

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Marc Onetto

Vital statistics

Born September 3, 1950, in Paris, France

Married, with 2 children

Education

Graduated with an MS in engineering in 1973 from École Centrale de Lyon and with an MBA in industrial administration in 1975 from Carnegie Mellon University's Tepper School of Business

Career highlights

Amazon.com (2006–13)

Senior vice president of worldwide operations and customer service

Solectron, now Flextronics International (2003–06)

Executive vice president of worldwide operations

GE (1988–2003)

Corporate vice president of European operations (2002–03)

GE Medical Systems, now GE Healthcare (1988–2002)

- Vice president and general manager, Global manufacturing and supply chain (1998–2002)
- General manager, Global quality (1997–98)
- General manager, Global tubes and detectors (1993–97)
- General manager, Europe services (1989–92)

Fast facts

Awarded the title of *Chevalier de l'Ordre National du Mérite*

Named "2002 French-American Executive of the Year" by Chicago's French-American Chamber of Commerce

Serves on the board of advisers for Carnegie Mellon University's Tepper School of Business

line with me, he was staffed in Receiving, which is where all of the defects that come from the ordering process and the delivering process arrive, and you have to deal with all sorts of problems. At the time, Amazon had just started its Fulfillment by Amazon business.[2] Some of the merchants were not very disciplined, so they were sending products that were not labeled or packed properly.

Bezos opened a box of shampoo and all of the bottles were broken. They spilled all over him and he nearly cut himself. No customer is going to buy shampoo if the bottle is broken, and we can't risk the health of the worker opening the package. So we agreed that we had to implement a "three strikes" packing process for merchants using our fulfillment services: the first time there is a problem we explain the packing rules, the second time we give the merchants a warning, and the third time we end their relationship as merchants with Amazon. That was one of the most memorable *kaizens* for me.

We also used *kaizen* at the workstation level to reach new productivity objectives for stowing products. Our goal has always been to stow products within a certain time period and with a certain number of frontline staff, because stowing accounts for about 20 percent of the costs in our fulfillment centers.

The challenge was that the productivity of our carts was very unpredictable: stowing a small book does not take the same time as stowing a computer screen. We spent time on the front line recording the time to stow different products, and we decided there were three types of carts. We defined products for each type and the time to stow those products. We then tested that idea and revised the process. We used *kaizen* to improve the standard work by reducing

[2] Fulfillment by Amazon is an option Amazon offers to its merchants, which can send the goods they are selling on Amazon to its fulfillment centers, so that the merchant's goods are shipped alongside Amazon goods.

Andon

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The *andon* cord is a Toyota innovation now common in many assembly environments. Frontline workers are empowered to address quality or other problems by stopping production.

stowing times, so we solved things bottom-up on the front line to achieve the top-down goals for productivity.

Our ideal *kaizen* teams are a combination of frontline workers, engineers, and a few executives who are going to ask questions and have no preconceived ideas. You put these people together and you say, "Here's a problem; we're going to improve it." Then you raise the bar on improvement. The *kaizen* team should be judged on results that will be meaningful for the company in the long term. You have to ask people to use their brains and their imaginations to solve problems.

Pulling the *andon* cord

Soon after I started at Amazon, I discussed implementing the *andon*-cord[5] principle in customer service. Bezos was enthusiastic about it right away and we implemented it in about six months. The process begins when a service agent gets a phone call from a customer explaining that there is a problem with the product he or she has just received from us. If it's a repetitive defect, we empower the customer-service agent to "stop the line," which means taking the product off the website until we fix the defect. The objective is to start the line again with the defect resolved. We created an entire background process to identify, track, and resolve these defects.

The *andon* cord has had an amazing impact; it eliminates tens of thousands of defects per year. The other wonderful thing is that the *andon* cord has empowered frontline workers. The authority to stop the line is an enormous proof of trust for customer-service agents, who usually have no real authority to help irate customers over the telephone. With the cord, the agents have been able to tell customers that the product has been placed in the lab for quality problems until the defect can be resolved. At the same time, they offer customers a new product or reimburse them. Customers can see products pulled for quality issues on the website in real time. This has created incredible energy and motivated our frontline people to do great work for our customers. Our frontline people's assessments are almost always correct: 98 percent of the time, the *andon* cord is pulled for a real defect—proof, if it were needed, that when you set up a good process, you can trust people on the front line to use it well.

Next frontiers

Perhaps the biggest challenge I see is the application of lean-management principles to software creation, which is highly complex, with numerous opportunities for defects. Software engineers have not yet been able to stop the line and detect defects in real time during development. The only real testing happens once the software is completed, with the customer as a beta tester. To me, this is unacceptable; we would never do that with a washing machine. We would not ask customers to tell us when the washer leaks or what's wrong with it once it has arrived at their homes. I've tried to address the problem, and some of Amazon's computer-science engineers have looked at it, but it is still one of the biggest challenges for lean.

On the other hand, I'm extremely excited about 3-D printing. I don't completely know what it means on a larger scale. Right now, Amazon is selling 3-D printers, but to my knowledge it has not yet expanded to actual products on demand. Perhaps some manufacturers are beginning to distribute 3-D printed products. It's not science fiction anymore, but it is still experimental.

It's fascinating because it's the concept of print on demand extended to absolutely any product. Today, in some fulfillment centers, there is printing equipment that allows Amazon to print and ship a book within four hours of a customer order for it. 3-D printing is just an extension of this concept to all sorts of goods other than books. The idea of making a product for the customer at the time the customer actually orders it is fascinating because that's what the creators of lean always dreamed about. It's the ultimate just in time.

Marc Onetto, a senior consultant at Amazon.com, was the company's senior vice president of worldwide operations and customer service from 2006 until 2013. Previously, he had been head of operations at GE Medical Systems, where he pioneered various lean initiatives. This commentary is adapted from an interview with **Allen Webb,** editor in chief of *McKinsey Quarterly*, who is based in McKinsey's Seattle office.

When big data goes lean

Rajat Dhawan, Kunwar Singh, and Ashish Tuteja

The combination of advanced analytics and lean management could be worth tens of billions of dollars in higher earnings for large manufacturers. A few leading companies are showing the way.

The application of larger data sets, faster computational power, and more advanced analytic techniques is spurring progress on a range of lean-management priorities. Sophisticated modeling can help to identify waste, for example, thus empowering workers and opening up new frontiers where lean problem solving can support continuous improvement. Powerful data-driven analytics also can help to solve previously unsolvable (and even unknown) problems that undermine efficiency in complex manufacturing environments: hidden bottlenecks, operational rigidities, and areas of excessive variability. Similarly, the power of data to support improvement efforts in related areas, such as quality and production planning, is growing as companies get better at storing, sharing, integrating, and *understanding* their data more quickly and easily.

Pioneers in the application of advanced-analytics approaches, some borrowed from risk management and finance, are emerging in industries such as chemicals, electronics, mining and metals, and pharmaceuticals. Many are lean veterans: these companies cut their teeth during the 1990s (when sagging prices hit a range of basic-materials companies hard) and more recently doubled down in response to rising raw-materials prices. The benefits they're enjoying—an extra two to three percentage points of margin, on top of earlier productivity gains (from conventional lean methods) that often reached 10 to 15 percent—suggest that more big data applications will be finding their way into the lean tool kits of large manufacturers.

Indeed, our work suggests that, taken together, the new uses of proven analytical tools could be worth tens of billions of dollars in EBITDA (earnings before interest, taxes, depreciation, and amortization) for manufacturers in the automobile, chemical, consumer-product, and pharmaceutical industries, among others (exhibit).

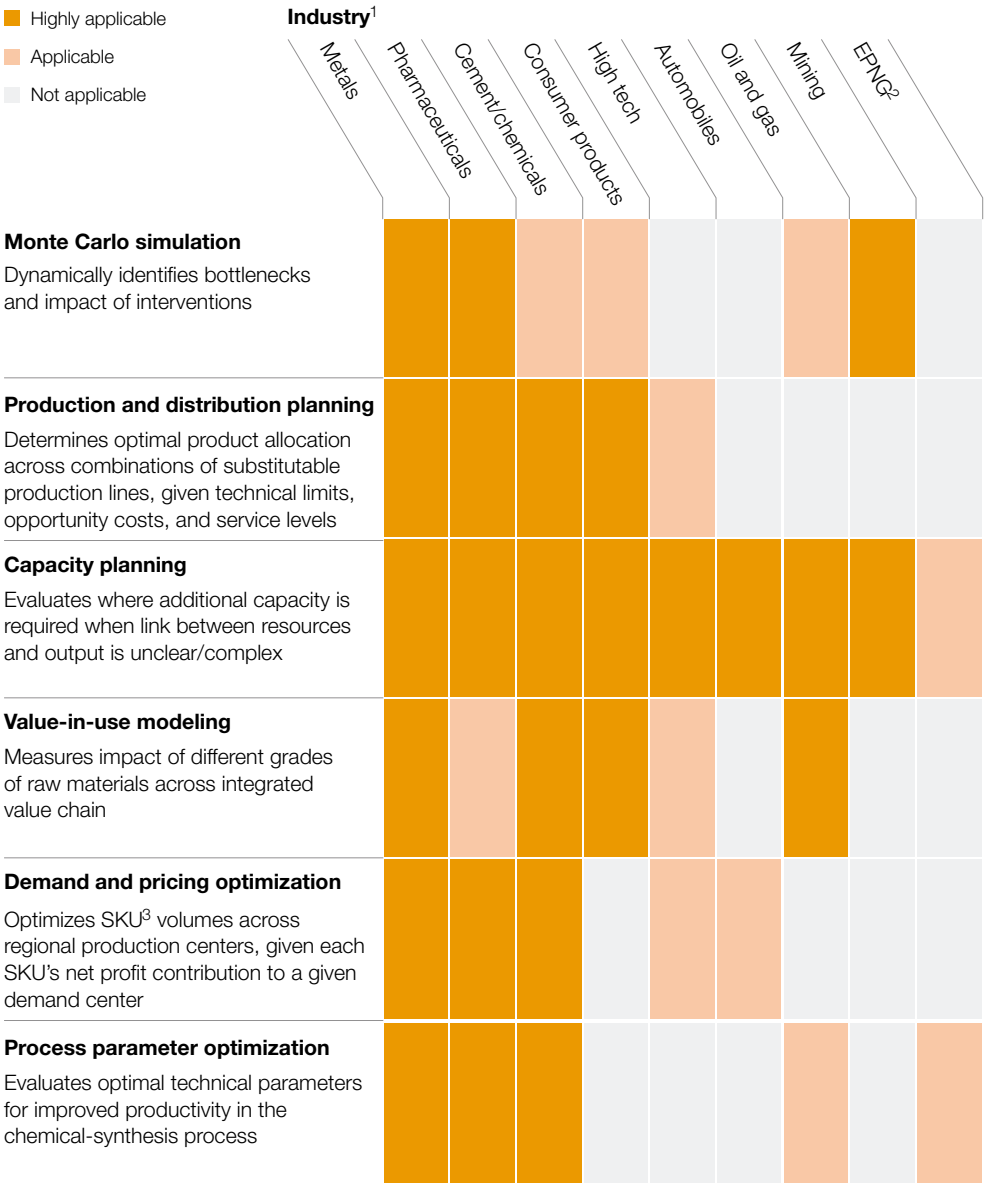
Nonetheless, to get the most from data-fueled lean production, companies have to adjust their traditional approach to *kaizen* (the philosophy of continuous improvement). In our experience, many find it useful to set up special data-optimization labs or cells within their existing operations units. This approach typically requires forming a small team of econometrics specialists, operations-research experts, and statisticians familiar with the appropriate tools. By connecting these analytics experts with their frontline colleagues, companies can begin to identify opportunities for improvement projects that will both increase performance and help operators learn to apply their lean problem-solving skills in new ways.

For example, a pharmaceutical company wanted to get to the root causes of variability in an important production process. Operators suspected that some 50 variables were involved but couldn't determine the relationships among them to improve overall efficiency. Working closely with data specialists, the operators used neural networks (a machine-learning technique) to model the potential combinations and effects of the variables. Ultimately, it determined that five of them mattered most. Once the primary drivers were clear, the operators focused their efforts on optimizing the relevant parameters and then managing them as part of routine plant operations. This helped the company to improve yields by 30 percent.

Similarly, a leading steel producer used advanced analytics to identify and capture margin-improvement opportunities worth more than $200 million a year across its production value chain. This result is noteworthy because the company already had a 15-year history of deploying lean approaches and had recently won an award for quality and process excellence. The steelmaker began with a Monte Carlo simulation, widely used in biology, computational physics, engineering, finance, and insurance to model ranges of possible outcomes and their probabilities. Manufacturing companies can adapt these methods to model their own uncertainties by running

Exhibit

New uses of proven analytical tools will serve manufacturers across a range of industries.



[1]Extrapolation over top 5 companies in each sector, assuming tools are applicable to only 30% of areas covered within a company and that ~3% additional earnings before interest, taxes, depreciation, and amortization (EBITDA) are unlocked.
[2]Electric power and natural gas.
[3]Stock-keeping unit.

The ability to solve previously unsolvable problems and make better operational decisions in real time is a powerful combination.

thousands of simulations using historical plant data to identify the probabilities of breakdowns, as well as variations in cycle times and in the availability of multiple pieces of equipment across parts of a production process.

The steelmaker focused on what it thought was the principal bottleneck in an important process, where previous continuous-improvement efforts had already helped raise output by 10 percent. When statisticians analyzed the historical data, however, they recognized that the process suffered from multiple bottlenecks, which shifted under different conditions. The part of the process that the operators traditionally focused on had a 60 percent probability of causing problems, but two other parts could also cripple output, though they were somewhat less likely to do so.

With this new understanding, the company conducted structured problem-solving exercises to find newer, more economical ways of making improvements. Given the statistical distribution of the bottlenecks, it proved more efficient to start with a few low-cost maintenance and reliability measures. This approach helped improve the availability of three key pieces of equipment, resulting in a 20 percent throughput increase that translated into more than $50 million in EBITDA improvements.

Monte Carlo simulation holds promise in other areas, too. A mining company, for instance, used it to challenge a project's capital assumptions, in part by deploying historical data on various disruptions—for example, rainfall patterns—to model the effect of floods and other natural events on the company's mines. This effort helped it to optimize handling and storage capacity across its whole network of facilities, thus lowering the related capital expenditures by 20 percent.

A second analytical tool the steelmaker employed was value-in-use modeling, long a fixture in procurement applications, where it helps to optimize the purchasing of raw materials. The steelmaker used these techniques to see how different blends of metallurgical coal[1] might affect the economics of its production activities. The team investigating the problem started with about 40 variables describing the specifications (such as ash content and impurities affecting production) of different types of coal. Later it added fuel consumption, productivity, and transport costs. This approach helped operators to identify and prioritize a series of plantwide *kaizen* activities that lowered the company's raw-materials costs by 4 to 6 percent. Moreover, procurement managers integrated the model's findings into their routines—for example, by monitoring and adjusting coal blends on a quarterly basis; previously, they might have done so only once or twice a year, because of the complexity involved.

As the steelmaker's example suggests, the key to applying advanced analytics in lean-production environments is to view data through the lens of continuous improvement and not as an isolated series of one-offs. The ability to solve previously unsolvable problems and make better operational decisions in real time is a powerful combination. More powerful still is using these advantages to encourage and empower frontline decision making. By pushing data-related issues lower in the organization, the steelmaker is encouraging a strong culture of continuous improvement. It is also identifying new areas to apply its growing proficiency in advanced analytics. One area is production planning, where the operations group is working

[1] A raw material that is converted to coke for use in steelmaking.

with internal marketing and sales, as well as external suppliers, to improve the accuracy of sales forecasts and make production more efficient.

The steelmaker's story shows that senior executives must take an active role. In our experience, the information and data required for many big data initiatives already exist in silos around companies—in shop-floor production logs, maintenance registers, real-time equipment-performance data, and even vendor performance-guarantee sheets. In some cases, data may come from outside partners or databases. Determining what to look for, where to get it, and how to use it across a dispersed manufacturing network requires executive know-how and support.

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Bringing lean thinking to energy

Markus Hammer, Paul Rutten, and Ken Somers

Beset by rising costs, resource-intensive manufacturers are applying lean-management thinking in new ways to reduce the amount of energy used in production, to increase resource productivity—or both.

Over the years, many global manufacturers have secured big gains in labor and capital productivity by applying the principles of lean manufacturing. Fewer companies, however, have applied lean know-how to energy productivity. Line workers and even senior managers often consider energy a given when they consider it at all. The waste of energy and resources is typically overlooked or excluded from lean problem solving on the grounds that it is too complex for the front line to address, cuts across too many functions, or both.

That's a mistake, given the importance of energy and raw materials as cost drivers. Indeed, for one LCD-television manufacturer we studied, energy represented 45 percent of total production costs. Meanwhile, for many "upstream" manufacturers (such as steel and chemical makers) energy typically accounts for up to 15 percent or more of overall production costs—the largest share after raw materials, which often account for at least 50 percent of the cost base. Our experience suggests that many of these manufacturers could reduce the amount of energy they use in production by as much as 30 percent (with similarly reduced resource losses), in part by applying lean principles and by shifting mind-sets to focus the organization on eliminating anything that doesn't add value for customers.

Consider, for example, the pharmaceutical company that applied lean manufacturing to a series of processes in its biological reactors, where it grew cell cultures. The combination of loss-mapping techniques along the production chain, deep statistical analysis, and rigorous brainstorming and problem-solving sessions with engineers and operators helped to identify improvements in the productivity of the biological resources. The company expects these improvements to boost yields by over 50 percent—without additional costs. This finding was noteworthy because even though the company was well versed in lean thinking and methods, its production team had initially taken variability in biological materials for granted (a common attitude).

By examining new areas formerly considered off-limits to lean, companies often generate rich opportunities. For example, a European chemical company used a lean value-stream analysis of raw-material flows in one of its businesses to understand which activities created value and which created waste. By comparing the theoretical minimum amounts of raw materials required in each stage of production with actual consumption, the company learned that up to 30 percent of its raw-material inputs were wasted. Moreover, some plants were far more wasteful than others, despite otherwise appearing quite efficient.

These discoveries prompted the company to prioritize a range of improvements—starting with how it sourced raw materials and extending to equipment and process changes in production—that together netted more than €50 million in annual savings. What's more, the analysis helped the company to optimize its plants' production rates to use energy more efficiently. Indeed, the company identified a narrow set of conditions in which the plants' energy consumption was *destroying* value—a situation it could now predict and avoid.

A chemical manufacturer used a similar approach to optimize its variable costs associated with both energy use and materials yields. Theoretical-limit analyses identified a series of process-control improvements, as well as opportunities to lower thermodynamic-energy losses and to optimize mechanical equipment. Taken together, these moves helped the company to reduce its energy consumption by 15 percent. Meanwhile, on the raw-material side, the company

combined theoretical-limit analysis with advanced statistical techniques (for more, see “When big data goes lean,” on page 97) to map the profit per hour of a set of activities. This approach helped the company to optimize the use of an important catalyst in production, to discover additional process parameters for fine tuning, and to improve the allocation of its production activities across the company’s different lines. All this, together with a few selected capital investments, ultimately helped to increase yields by 20 percent (or, in lean terms, to cut yield losses by 20 percent—a savings equivalent to a plant’s entire fixed cost for labor).

There was also one extra benefit. The use of the catalyst had always resulted in two by-products, both of which the company sold, though at different prices. Now that the workers had a better understanding of how profits in the plant varied hour by hour (an important mind-set shift), the company could maximize the profits gained from the more expensive by-product. That opportunity was worth an additional €1 million to €2 million a year.

While all of these examples are impressive on their own, perhaps more impressive is the enduring power of lean principles to generate unexpected savings when companies gain greater levels of insight into their operations—for example, through the use of advanced analytics or profit-per-hour analyses. In the years ahead, as emerging-market growth continues to boost demand for resources and to spur commodity-price volatility, more and more companies should have incentives to experience this power for themselves.

Markus Hammer is a senior expert in McKinsey’s Lisbon office, **Paul Rutten** is a principal in the Amsterdam office, and **Ken Somers** is a master expert in the Antwerp office.

(Still) learning from Toyota

Deryl Sturdevant

A retired Toyota executive describes how to overcome common management challenges associated with applying lean, and reflects on the ways that Toyota continues to push the boundaries of lean thinking.

In the two years since I retired as president and CEO of Canadian Autoparts Toyota (CAPTIN), I've had the good fortune to work with many global manufacturers in different industries on challenges related to lean management. Through that exposure, I've been struck by how much the Toyota production system has already changed the face of operations and management, and by the energy that companies continue to expend in trying to apply it to their own operations.

Yet I've also found that even though companies are currently benefiting from lean, they have largely just scratched the surface, given the benefits they *could* achieve. What's more, the goal line itself is moving—and will go on moving—as companies such as Toyota continue to define the cutting edge. Of course, this will come as no surprise to any student of the Toyota production system and should even serve as a challenge. After all, the goal is continuous improvement.

Room to improve

The two pillars of the Toyota way of doing things are *kaizen* (the philosophy of continuous improvement) and respect and empowerment for people, particularly line workers. Both are absolutely required in order for lean to work. One huge barrier to both goals is complacency. Through my exposure to different manufacturing environments, I've been surprised to find that senior managers often feel they've been very successful in their efforts to emulate Toyota's production system—when in fact their progress has been limited.

The reality is that many senior executives—and by extension many organizations—aren't nearly as self-reflective or objective about evaluating themselves as they should be. A lot of executives have a propensity to talk about the good things they're doing rather than focus on applying resources to the things that aren't what they want them to be.

When I recently visited a large manufacturer, for example, I compared notes with a company executive about an evaluation tool it had adapted from Toyota. The tool measures a host of categories (such as safety, quality, cost, and human development) and averages the scores on a scale of zero to five. The executive was describing how his unit scored a five—a perfect score. "Where?" I asked him, surprised. "On what dimension?"

"Overall," he answered. "Five was the average."

When he asked me about my experiences at Toyota over the years and the scores its units received, I answered candidly that the best score I'd ever seen was a 3.2—and that was only for a year, before the unit fell back. What happens in Toyota's culture is that as soon as you start making a lot of progress toward a goal, the goal is changed and the carrot is moved. It's a deep part of the culture to create new challenges constantly and not to rest when you meet old ones. Only through honest self-reflection can senior executives learn to focus on the things that need improvement, learn how to close the gaps, and get to where they need to be as leaders.

A self-reflective culture is also likely to contribute to what I call a "no excuse" organization, and this is valuable in times of crisis. When Toyota faced serious problems related to the unintended acceleration of some vehicles, for example, we took this as an opportunity to revisit everything we did to ensure quality in the design of vehicles—from engineering and production to the manufacture of parts and so on. Companies that can use crises to their advantage will always excel against self-satisfied organizations that already feel they're the best at what they do.

A common characteristic of companies struggling to achieve continuous improvement is that they pick and choose the lean tools they want to use, without necessarily understanding how these tools operate as

a system. (Whenever I hear executives say "we did *kaizen*," which in fact is an entire philosophy, I know they don't get it.) For example, the manufacturer I mentioned earlier had recently put in an *andon* system, to alert management about problems on the line.[1] Featuring plasma-screen monitors at every workstation, the system had required a considerable development and programming effort to implement. To my mind, it represented a knee-buckling amount of investment compared with systems I'd seen at Toyota, where a new tool might rely on sticky notes and signature cards until its merits were proved.

An executive was explaining to me how successful the implementation had been and how well the company was doing with lean. I had been visiting the plant for a week or so. My back was to the monitor out on the shop floor, and the executive was looking toward it, facing me, when I surprised him by quoting a series of figures from the display. When he asked how I'd done so, I pointed out that the tool was broken; the numbers weren't updating and hadn't since Monday. This was no secret to the system's operators and to the frontline workers. The executive probably hadn't been visiting with them enough to know what was happening and why. Quite possibly, the new system receiving such praise was itself a monument to waste.

Room to reflect

At the end of the day, stories like this underscore the fact that applying lean is a leadership challenge, not just an operational one. A company's senior executives often become successful as leaders through years spent learning how to contribute inside a particular culture. Indeed, Toyota views this as a career-long process and encourages it by offering executives a diversity of assignments, significant amounts of training, and even additional college education to help prepare them as lean leaders. It's no surprise, therefore, that should a company bring in an initiative like Toyota's production system—or any lean initiative requiring the culture to change fundamentally—its leaders may well struggle and even view the change as a threat. This is particularly true of lean because, in many cases, rank-and-file workers know far more about the system from a "toolbox standpoint" than do executives, whose job is to understand how the

[1] Many executives will have heard of the *andon* cord, a Toyota innovation now common in many automotive and assembly environments: line workers are empowered to address quality or other problems by stopping production.

whole system comes together. This fact can be intimidating to some executives.

Senior executives who are considering lean management (or are already well into a lean transformation and looking for ways to get more from the effort and make it stick) should start by recognizing that they will need to be comfortable giving up control. This is a lesson I've learned firsthand. I remember going to CAPTIN as president and CEO of the company and wanting to get off to a strong start. Hoping to figure out how to get everyone engaged and following my initiatives, I told my colleagues what I wanted. Yet after six or eight months, I wasn't getting where I wanted to go quickly enough. Around that time, a Japanese colleague told me, "Deryl, if you say 'do this' everybody will do it because you're president, whether you say 'go this way,' or 'go that way.' But you need to figure out how to manage these issues having absolutely no power at all."

So with that advice in mind I stepped back and got a core group of good people together from all over the company—a person from production control, a night-shift supervisor, a manager, a couple of engineers, and a person in finance—and challenged *them* to develop a system. I presented them with the direction but asked them to make it work.

And they did. By the end of the three-year period we'd set as a target, for example, we'd dramatically improved our participation rate in problem-solving activities—going from being one of the worst companies in Toyota Motor North America to being one of the best. The beauty of the effort was that the team went about constructing the program in ways I never would have thought of. For example, one team member (the production-control manager) wanted more participation in a survey to determine where we should spend additional time training. So he created a storyboard highlighting the steps of problem solving and put it on the shop floor with questionnaires that he'd developed. To get people to fill them out, his team offered the respondents a hamburger or a hot dog that was barbecued right there on the shop floor. This move was hugely successful.

Another tip whose value I've observed over the years is to find a mentor in the company, someone to whom you can speak candidly. When you're the president or CEO, it can be kind of lonely, and you won't have anyone to talk with. I was lucky because Toyota has a

robust mentorship system, which pairs retired company executives with active ones. But executives anywhere can find a sounding board—someone who speaks the same corporate language you do and has a similar background. It's worth the effort to find one.

Finally, if you're going to lead lean, you need knowledge and passion. I've been around leaders who had plenty of one or the other, but you really need both. It's one thing to create all the energy you need to start a lean initiative and way of working, but quite another to keep it going—and that's the real trick.

Room to run

Even though I'm retired from Toyota, I'm still engaged with the company. My experiences have given me a unique vantage point to see what Toyota is doing to push the boundaries of lean further still.

For example, about four years ago Toyota began applying lean concepts from its factories beyond the factory floor—taking them into finance, financial services, the dealer networks, production control, logistics, and purchasing. This may seem ironic, given the push so many companies outside the auto industry have made in recent years to drive lean thinking into some of these areas. But that's very consistent with the deliberate way Toyota always strives to perfect something before it's expanded, looking to "add as you go" rather than "do it once and stop."

Of course, Toyota still applies lean thinking to its manufacturing operations as well. Take major model changes, which happen about every four to eight years. They require a huge effort—changing all the stamping dies, all the welding points and locations, the painting process, the assembly process, and so on. Over the past six years or so, Toyota has nearly cut in half the time it takes to do a complete model change.

Similarly, Toyota is innovating on the old concept of a "single-minute exchange of dies"[2] and applying that thinking to new areas, such

[2] Quite honestly, the single-minute exchange of dies aspiration is really just that—a goal. The fastest I ever saw anyone do it during my time at New United Motor Manufacturing (NUMMI) was about 10 to 15 minutes.

as high-pressure injection molding for bumpers or the manufacture of alloy wheels. For instance, if you were making an aluminum-alloy wheel five years ago and needed to change from one die to another, that would require about four or five hours because of the nature of the smelting process. Now, Toyota has adjusted the process so that the changeover time is down to less than an hour.

Finally, Toyota is doing some interesting things to go on pushing the quality of its vehicles. It now conducts surveys at ports, for example, so that its workers can do detailed audits of vehicles as they are funneled in from Canada, the United States, and Japan. This allows the company to get more consistency from plant to plant on everything from the torque applied to lug nuts to the gloss levels of multiple reds so that color standards for paint are met consistently.

The changes extend to dealer networks as well. When customers take delivery of a car, the salesperson is accompanied by a technician who goes through it with the new owner, in a panel-by-panel and option-by-option inspection. They're looking for actionable information: is an interior surface smudged? Is there a fender or hood gap that doesn't look quite right? All of this checklist data, fed back through Toyota's engineering, design, and development group, can be sent on to the specific plant that produced the vehicle, so the plant can quickly compare it with other vehicles produced at the same time.

All of these moves to continue perfecting lean are consistent with the basic Toyota approach I described: try and perfect anything before you expand it. Yet at the same time, the philosophy of continuous improvement tells us that there's ultimately no such thing as perfection. There's always another goal to reach for and more lessons to learn.

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Applied Insight

Tools, techniques, and frameworks for managers

Illustration by Neil Webb

Preparing for bigger, bolder shareholder activists

Joseph Cyriac, Ruth De Backer, and Justin Sanders

Activists are targeting more and bigger companies. Here's what attracts them—and some tips on how to respond when they show up.

Activist investors[1] are getting ever more adventurous. Last year, according to our analysis, the US-listed companies that activists targeted had an average market capitalization of $10 billion—up from $8 billion just a year earlier and less than $2 billion at the end of the last decade. They've also been busier, launching an average of 240 campaigns in each of the past three years—more than double the number a decade ago. And even though activists are a relatively small group, with only $75 billion in combined assets under management compared with the $2.5 trillion hedge-fund industry overall, they've enjoyed a higher rate of asset growth than hedge funds and attracted new partnerships with traditional investors. As a result, they have both the capital and the leverage to continue engaging large-cap companies.

Shareholders generally benefit. Our analysis of 400 activist campaigns (out of 1,400 launched against US companies over the past decade) finds that, among large companies for which data are available, the median activist campaign reverses a downward trajectory in target-company performance and generates excess shareholder returns that persist for at least 36 months (exhibit).[2]

Internationally, others have reached similar conclusions.[3] That's consistent with a general shift in the tone of the debate around activist involvement. Today, we encounter more awareness of the positive effects that an activist campaign can have—on improving strategy and operations, for example, or strengthening the board of directors, or even mitigating perceived pressure for short-term performance.

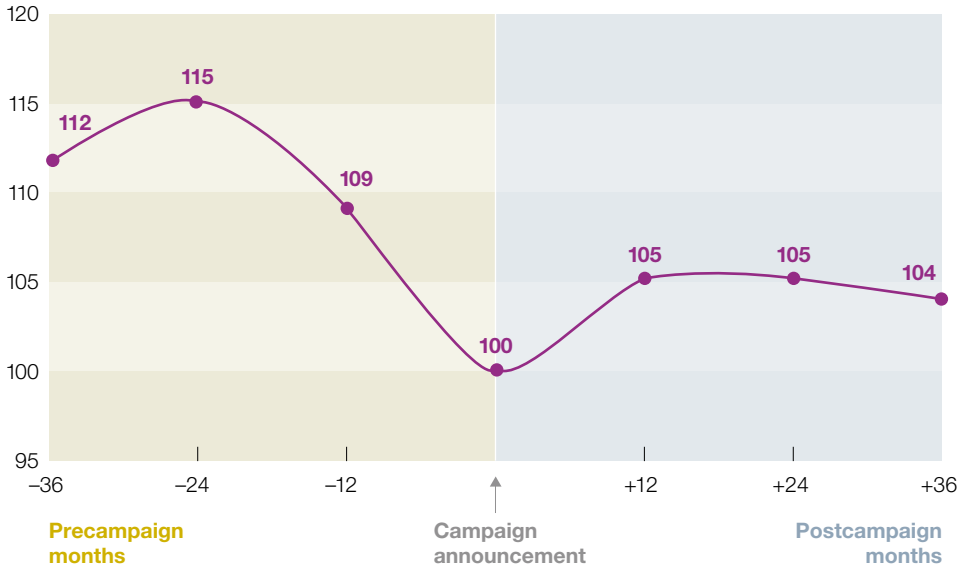
But that presents a challenge for executives, many of whom reflexively resist activists, should they make an approach. Activists themselves often provoke that response, our analysis finds, with confrontational or even acerbic overtures. Those executives who can set aside tone and style, though, will find that some activists do indeed have ideas that create value and improve shareholder performance. In fact, a collaborative, negotiated, or settled response to activist initiatives tends to lead to higher excess shareholder returns than a combative one.

In order to shape the kind of relationship they want with activists, managers must first understand what attracts them. Then they can gauge their own vulnerability to undertake for themselves the kinds of

Exhibit

Activist campaigns, on average, generate a sustained increase in shareholder returns.

Excess TRS[1] **performance of activist campaigns,** at companies with annual revenues of >$1 billion, 2001–present[2]; index: 100 = day of campaign announcement



[1] Total returns to shareholders relative to industry average.
[2] N = 67. For purposes of this chart we chose a more conservative sample that includes campaigns at companies with annual revenues of >$1 billion for which historical 6-year TRS data are available. The trend is similar for a broader set of 112 companies of all sizes.

Source: Thomson Reuters' Datastream; Standard & Poor's Capital IQ; McKinsey analysis

value-creating actions an activist would likely propose. They should also have plans at the ready for responding, well in advance of an activist's overture.

What attracts activist shareholders?

An activist campaign itself can be costly for management, both in direct expenses and in the significant time and attention diverted from running the business. Our interviews suggest that each contested campaign costs a company between $10 million and $20 million—plus weeks of management time to develop plans and meet with investors. Executives who can identify and address the weak spots that an activist would target before an activist gets involved can help a company reap the benefits without incurring the cost—whether through preemptive actions or a fast path to compromise should an activist launch a campaign.

What are those weak spots? Not unexpectedly, our research finds that fundamental underperformance is the most likely weakness to trigger an activist investor. Most often, activists focus on underperformance relative to

industry peers, rather than absolute declines in performance, and they especially react to shareholder returns that have significantly lagged behind the industry in the previous two years, anemic revenue growth, and a growing gap in margins relative to peers. Large cash balances and recurring restructuring charges are also strong indicators of looming activism. Notably, in our research, we found that executive compensation and a company's gap in consensus earnings do not appear to be significant indicators of activist interest despite the frequent use of these metrics in activist-campaign rhetoric. If a company shows signs of underperformance relative to peers, it's quite likely that an activist is already watching.

Executives can run a preemptive activist audit to evaluate their company's fundamental performance—and we've observed a growing number of companies doing so, proactively testing whether they may be a target and reviewing their operating and strategic plans in that light. A rigorous and unbiased preemptive audit that identifies weak spots and evaluates all options can help keep activists at bay and uncover opportunities for value creation. One company took a detailed look at performance trends against peers and dug deep into the fundamental factors creating value for each of its business segments. Armed with this information, it was able to better understand the intrinsic value of each of its businesses and compare this with how the market valued the sum of the parts. Finally, it considered all possible options for closing the gap, including operational improvements, changes in capital allocation and financing, and fundamental changes to its portfolio.

In certain sectors, we have also observed a pattern of industry-specific investment theses. For example, industrial companies are attractive targets where the breadth of the corporate portfolio leads to a market value lower than the sum of the independent businesses. Other tempting targets are basic-materials companies with stranded or undervalued raw-material assets and pharmaceuticals companies with drug pipelines (R&D or production) perceived to be weaker than those of their peers.

What to do when approached by an activist

If an activist does reach out, how executives react plays a big part in how collaborative or hostile a campaign gets. Three in four campaigns start collaboratively, our research finds, but half of those eventually turn hostile. This suggests that management teams should think as much about how they engage with an activist as whether they accept activist proposals.

Some tips can help in planning response tactics.

Form a response team. When an activist engages a management team, executives should pull together an ad hoc team to respond. Those who respond without team support can easily make missteps, underestimating the gravity of the overture or overlooking the full range of options; this can lead to a rapid escalation of an activist's moves. In one recent instance, the chair of a health-care company's board, in the face of an aggressive overture from a large activist

shareholder, made a unilateral decision to ignore an activist—which provoked the activist to campaign for board control. Contrast that with another recent example, where the CEO of a global industrial company quickly assembled a confidential working team including himself, his CFO, his general counsel, investor relations, and a support analyst. The team quickly assessed the benefits and risks of the activist proposal and generated a plan for compromise that enabled the CEO to settle an activist campaign by proactively gaining support from large shareholders for his plan.

This variability in response tactics exposes executives to significant risk—often driven by emotion. Agreeing on a team structure and governance in advance can be a highly effective tool for preventing unilateral decisions with great consequences. It matters less that the team members are known and named in advance and more that there is a clear set of guideposts in place for how an executive team will manage its reaction. Clear governance and process are the best defense against inadvertent decisions in the heat of confrontation.

Moreover, the right team will look different depending on whom activists first approach, for example, and what kinds of suggestions they bring. If they approach the board, members may want a team that includes more independent external voices than if they first approach the CEO, who may want a less public and even internally confidential team for tactical analysis, planning, and communication. And the types of recommendations the activist makes will also heavily influence the makeup of the response team, since the team will need different insights to weigh a proposed new strategic direction rather than potential structural changes or financial engineering.

Internal team members will naturally include the executive team, board members, general counsel, and investor relations. External advisers are also essential to the process. Legal advisers are often the first call, but strategic, financial, and communications specialists all play a valuable role in driving shareholder returns while preserving company leadership. Many advisers will push for a poison pill or other structural defenses. Yet this approach can give a false sense of protection as activists seek support from other large shareholders rather than attempt an outright corporate takeover. The experience at one global retailer highlights this dynamic. The shareholder involved continued his campaign even after the board adopted a poison-pill approach that would have diluted shareholders in the event of a hostile takeover bid. It wasn't until the company won shareholder support for its own plan by clarifying its intentions that the activist withdrew. The addition of strategic and communications specialists to help inform investors played an important role in management retaining control of the company.

Understand the activist. As with most negotiations, what actions you take depends on what kind of counterparty is engaging you—and response teams need to quickly develop a point of view on the specific activist's tactics, methods for engaging shareholders, track record, and industry experience. There are no

clear-cut definitions of hostile versus collaborative activist investors, but the nature of their initial overture, the thoughtfulness of their proposals, and their track record at creating value offer important indications of the kind of campaign you're likely to face.

Campaigns tend to be hostile if the activist's objective is a change in governance or legal matters, such as revisions to bylaws, for example, rather than strategic or M&A-oriented proposals. Aside from that, certain activists have a propensity toward more collaborative interactions with management teams. They launch their campaigns with private letters to management and one-on-one discussions with executives. Less collaborative activists launch campaigns with more confrontational approaches, such as open letters or proxy statements. Our analysis suggests that more hostile investors will openly threaten a fight or launch a proxy contest in up to 70 percent of their campaigns, while more collaborative activists remain cooperative in 70 percent of their campaigns.

Similarly, some activist funds offer detailed and thoughtful perspectives on a target's strategic and operational challenges, while others offer only vague assertions and aggressive plans for engineered returns. In the first case, management can gain useful perspectives on increasing returns to shareholders. In the second, an activist's proposals could represent significant risks to long-term health. In interviews with executives, we have observed that companies whose managers engage in a dialogue with activist shareholders in advance of a 13D filing often gain important context and insight into the activist's intentions. We've also heard repeatedly that an early move to cooperate or compromise leads to a collaborative dynamic, whereas lack of engagement or outright rejection of activist suggestions leads to a more hostile dynamic.

Understand the activist's proposal. In addition to assessing the activist, the response team needs to evaluate the activist's argument, understand its potential for value creation, and assess any potential risks to the company. Managers at one industrial company, for example, assembled a response team of internal and external specialists in a structure similar to an M&A due diligence. Through this war-room format, they evaluated direct and indirect benefits and costs of the activist proposal compared with existing plans, applying the same rigor to the review of each plan in order to identify the best path. When they ultimately recommended that the board accept significant portions of the activist plan, managers did so with the same level of detailed support they would ascribe to their own strategic plans.

Develop a response plan. Most of the executives we interviewed commented that activists' initial rounds of communication often come across as confrontational and sometimes disrespectful. We believe that it's important to see past this and acknowledge the activist in a manner that encourages a constructive dialogue. Our research suggests that acknowledging activists respectfully, constructively, and quickly—within days, followed by real engagement within weeks—and engaging them on the merits of their proposal helps avoid

major disruptions and preserve management control.

As crucial, if not more so, is engaging other large shareholders in explicit, proactive dialogue about an activist's proposal compared with management's alternative. In most cases, activist investors have themselves polled large shareholders and lobbied for support. In one recent example of a successfully negotiated settlement with an activist, the key success factor was a blitz of investor outreach that included clear management plans, an introduction of new team members, and examples of the company's management track record. In response to this outreach, large shareholders stood by management rather than support the activist. It would be naive for a management team not to open this type of shareholder dialogue and expect a beneficial outcome from an activist negotiation.

[1]Activist investors are defined as investment-management firms—most often hedge funds—that have acquired beneficial ownership of a company and filed a form 13D indicating intent to influence a management team.

[2]We defined large companies as those with at least $1 billion in annual revenues. The trends were similar for companies with revenues below $1 billion.

[3]Marco Becht et al., "The returns to hedge fund activism: An international study," European Corporate Governance Institute, finance working paper, Number 402/2014, January 2012, revised March 2013, ecgi.org.

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The full version of this article is available on mckinsey.com.

Building a forward-looking board

Christian Casal and Christian Caspar

Directors should spend a greater share of their time shaping an agenda for the future.

Debate over the role of company boards invariably intensifies when things go wrong on a grand scale, as has happened in recent years. Many of the companies whose corpses litter the industrial and financial landscape were undermined by negligent, overoptimistic, or ill-informed boards prior to the financial crisis and the ensuing deep recession. Not surprisingly, there's been a renewed focus on improved corporate governance: better structures, more rigorous checks and balances, and greater independence by nonexecutives, for example.

Governance arguably suffers most, though, when boards spend too much time looking in the rear-view mirror and not enough scanning the road ahead. We have experienced this reality all too often in our work with companies over several decades. It has also come through loud and clear during recent conversations

with 25 chairmen of large public and privately held companies in Europe and Asia. Today's board agendas, indeed, are surprisingly similar to those of a century ago, when the second Industrial Revolution was at its peak. Directors still spend the bulk of their time on quarterly reports, audit reviews, budgets, and compliance—70 percent is not atypical—instead of on matters crucial to the future prosperity and direction of the business.

The alternative is to develop a dynamic board agenda that explicitly highlights these forward-looking activities and ensures that they get sufficient time over a 12-month period. The exhibit illustrates how boards could devote more of their time to the strategic and forward-looking aspects of the agenda. This article discusses ways to achieve the right balance.

The case for change

Our conversations with successful chairmen showed a strong continuing bias toward fiduciary tasks but also a desire and willingness to shift focus. "Boards need to look further out than anyone else in the company," commented the chairman of a leading energy company. "There are times when CEOs are the last ones to see changes coming."

This forward-looking imperative comes in part from the way long-term economic, technological, and demographic trends are radically reshaping the global economy, making it more complex to oversee a successful multinational business. As executive teams grapple with the immediate challenge of volatile and unpredictable markets, it's more vital than ever for directors to remain abreast of what's on (or coming over) the horizon.

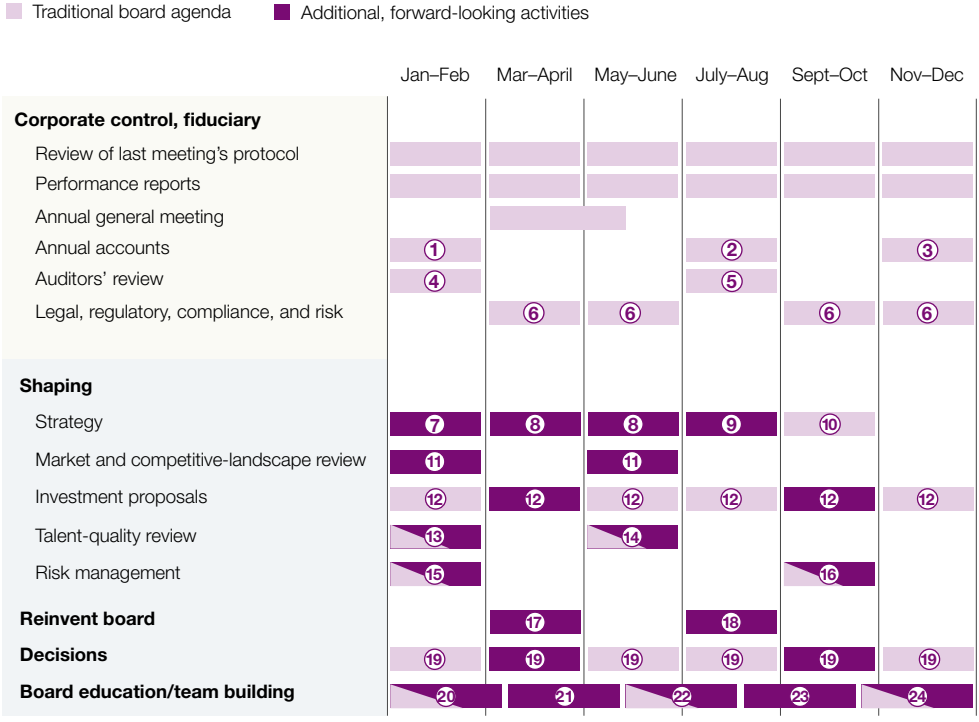
Second, and compounding the short-term executive mind-set, the length of CEO tenures remains relatively low—just five to six years now. That inevitably encourages incumbents to focus unduly on the here and now in order to meet performance expectations. Many rational management groups will be tempted to adopt a short-term view; in a lot of cases, only the board can consistently take the longer-term perspective.

Distracted by the details of compliance and new regulations, however, many directors we meet simply don't know enough about the fundamentals and long-term strategies of their companies to add value and avoid trouble. It doesn't have to be this way. A select handful of banks and other multinational corporations with prudent, farsighted, and independent-minded boards not only survived the financial crisis largely intact but also continue to thrive.

Rather than seeing the job as supporting the CEO at all times, the directors of these companies engage in strategic discussions, form independent opinions, and work closely with the executive team to make sure long-term goals are well formulated and subsequently met. How can a board better focus on the long term and avoid becoming a prisoner of the past?

Exhibit

How forward-looking boards should spend their time



Details on selected activities (all others are self-explanatory, as labeled)

Fiduciary
1. Annual accounts
2. Annual budget directives
3. Next year's budget
4. Auditors' report
5. Audit-planning approach
6. Audit-committee reviews

Strategy
7. Set framework for the year
8. Define broad options
9. Outline/select options
10. Approve final strategy approach
11. Review strategic and competitive position, key performance indicators

Investment
12. Engage in ongoing review of investment proposals

Talent
13. Set talent-review objectives for the year
14. Review top 30–50 people

Risk
15. Determine risk-review objectives for the year
16. Conduct annual risk review, including mitigation approaches

Board reinvention
17. Conduct board 360° evaluation
18. Determine approach for board-process enhancement

Decisions
19. Engage in decision making—eg, on budgets, investments, M&A, and key nominations

Board education
20. Travel with sales staff, customer visits
21. Visit R&D facilities
22. Visit new geographies
23. Inspect production sites
24. Attend customer conference

Foundations of a forward-looking board

Board chairmen and fellow directors will quickly grasp the point by studying the exhibit. The light-purple part of the annual schedule depicts how a board preoccupied with its fiduciary responsibilities typically spends its time. The dark-purple agenda items, by contrast, show what the calendar focus of a predominantly forward-looking board might look like. It's impossible to effect this change without a solid foundation: the right directors, knowledgeable about their roles and able to commit sufficient time.

Roll back the future to access top board members

Too often, vacancies on a board are filled under pressure, without an explicit review of its overall composition. An incoming chairman should try to imagine what his or her board might look like, ideally, three years from now. What kinds of skills and experience not currently in place will help fulfill the company's long-term strategy? What, in other words, is the winning team? A willingness to look ahead expands the number of candidates with appropriate skills and heightens the likelihood that they will sign up if and when they become available.

One of the world's leading food companies used this approach to introduce a range of expertise clearly reflecting its strategic direction and requirements. Of course, its board has high-profile (former) executives and top professionals with a profound finance, risk, or general-management background and diverse geographic experience. But now it also includes people with successful track records in health, nutrition, the public sector, and welfare. Other companies need specific kinds of expertise to help them adapt to cutting-edge technologies or market disruptions. Here, advisory boards without formal governance authority are especially useful.

Define the board's role clearly

The familiar roles of a well-functioning board—such as setting strategy, monitoring risks, planning the succession, and weighing in on the talent pipeline—are easy to list. But in practice, things are never simple. CEOs and their top teams, for example, are often touchy about what they see as board interference. Equally, weighty boards with years of experience and members used to getting their own way are frequently frustrated because they can't intervene more actively or their advice is ignored.

It's critical to defuse these tensions at the outset by clearly defining the board's role and establishing well-understood boundaries. Unless roles are clear, the relationship between the CEO and management, on the one hand, and the board, on the other, risks devolving into misunderstandings, loss of trust, and ineffectiveness. An annual discussion between the board and management, perhaps including a written letter of understanding setting out the roles of each party, is always a productive exercise. For instance, a large Nordic investment company creates work and role descriptions, for the board and management, that are reviewed and approved every

year. This process always generates valuable discussions and makes roles more clear.

Get your board to work harder

Most board members we know are hard working. The old caricature of long lunches and big stipends is just that—a caricature.

Yet the 10 or 12 days a year many board members spend on the job isn't enough, given the importance of their responsibilities. Several well-performing boards prescribe a commitment of up to 25 days of engagement for nonexecutive board members. (For related research, see "High-performing boards: What's on their agenda?," on page 12.)

Some of that extra time should be spent in the field. Boards seeking to play a constructive, forward-looking role must have real knowledge of their companies' operations, markets, and competitors. One big international industrial company we know requires all its board members to travel with salesmen on customer visits at some point each year. Other companies ask their directors to visit production and R&D facilities. The chairman of a manufacturing company we interviewed adds that "You can't fully understand the business, analyze the competition, review succession plans, visit a company's facilities, travel with salespeople, and set strategic goals by working a handful of days."

How can companies achieve the right degree of commitment? Higher pay will not be the answer, even if there were no governance watchdogs who would doubtless conclude that directors are already well paid or at least rarely need the extra money. The question of pay has never been an issue at a major oil company that requires its board members to set aside 30 days a year, for example. What does actually help (as in this case) is a board environment that encourages participation and allows board members to derive meaning, inspiration, and satisfaction from their work. The reward for individuals will be an opportunity to enhance their reputation for good boardroom oversight, to strengthen their personal networks, and to influence decisions.

Putting the board's best foot forward

The best boards act as effective coaches and sparring partners for the top team. The challenge is to build processes that help companies tap the accumulated expertise of the board as they chart the way ahead. Here are four ways to encourage a forward-looking mind-set.

Require the board to study the external landscape

As a starting point, says the chairman of a finance company, "We invite renowned experts and professionals in various fields—such as technology, regulatory matters, and economics—to board meetings, who talk about specific topics." Board meetings also may be held in overseas locations where directors can be exposed to new technologies and market developments relevant to a company's strategy.

To be able to challenge management with critical questions, a company's directors should regularly compare internal performance data with those of their competitors across a range of key indicators. The chairman of one telecommunications company says his board "regularly develops an outside–in view of the industry and business from public information. And from time to time, we seek outside advice to get an independent view on the firm's strategy and new potential development areas."

Make strategy part of the board's DNA

The central role of the board is to cocreate and ultimately agree on the company's strategy. In many corporations, however, CEOs present their strategic vision once a year, the directors discuss and tweak it at a single meeting, and the plan is then adopted. The board's input is minimal, and there's not enough time for debate or enough in-depth information to underpin proper consideration of the alternatives.

What's required is a much more fluid strategy-development process: management should prepare a menu of options that commit varying levels of resources and risks. In this way, board and management jointly define a broad strategic framework, and management defines options for board review. Finally, during a special strategy day, the board and management ought to debate, refine, and agree on a final plan. "At the beginning of the annual planning process, the board's role is to help management broaden the number of strategy options," says the chairman of a large transportation company. "At midyear, it is to discuss strategic alternatives and help select the preferred route, and at end of year, it is to make the final decision to implement."

Strategy should always provide the context for proposed acquisitions or stand-alone investments. "Without reference to long-term objectives, stand-alone investment proposals do not make much sense—but they are not unusual," says the chairman of a bank. Strategy and policy go hand in hand. Policy is not only among the most powerful tools a company can use to propel its culture and employee behavior in new directions but can also contribute significantly to the effective implementation of strategy. Yet most boards are aware of neither the full set of company policies nor their content.

Unleash the full power of your people

Forward-looking boards are powerfully positioned to focus on long-term talent-development efforts because they understand the strategy and can override some of the personal ties that cloud decision making over appointments. Divisional managers, say, might be tempted to hang on to high performers even if the company's interest would be to reallocate their skills and experience to a business with more potential. For example, a large media company, prompted by its board, recently reassigned its strategic-planning director to lead digital development projects on the US West Coast. The move was remarkably successful: working in close cooperation with some of the most accomplished digital giants in the United States, the business quickly got up to speed on the newest technological trends.

Many forward-looking boards hold annual reviews of the top 30 to 50 talents, always with an eye on those who might eventually be suitable for key executive roles. Here's how the process works in one manufacturing company. Each executive director selects, for presentation to the board, three to five promising managers. The board gets a photograph, information on their educational background, and performance reviews over the last three years. The presenter organizes the information on an evaluation grid showing categories such as performance, leadership, teamwork, and personal development. The directors then spend 10 to 30 minutes on each person, discussing key questions. How can the company coach and develop talented people? What personal and professional development opportunities, such as an international posting, might help broaden an individual's experience? What are the potential next career steps? In addition, during corporate projects, client gatherings, and trade shows, directors should take any opportunity to meet—and assess—upcoming executives and fast trackers informally.

The key is that the board must agree with management on a sensible approach to reviewing executive talent. Appointing a board member with a successful people-leadership track record to lead the effort is one way of boosting its impact.

Anticipate the existential risks

Every company has to take significant risks. But while it has long been understood that overall responsibility for risk management lies with boards, they often overlook existential risks. These are harder to grasp—all the more so for executives focused on the here and now—yet harm companies to a far greater extent than more readily identifiable business risks.

"Instead of only discussing competitive risks, boards should put in place a well-functioning crisis-management system" for cybercrime, insider trading, or corruption, says a consumer-goods company chairman conscious of the dangers of corporate secrets falling into the wrong hands. "We want to be ready for existential risks if they occur."

The best-managed companies in safety-sensitive sectors such as oil or autos—where a rig explosion or product recall could have significant consequences for large numbers of people or cost a year's profits—are already vigilant in this area. The board of one oil-exploration company we know regularly receives reports on the safety record of its on-platform activities. The reports trigger intense discussions about the root causes of problems and remedial action where there is any deviation from norms. The boards of other businesses should also demand that management supply quarterly reports (probably to the audit committee) on the observance of safety, quality, and ethical standards and hold management to account. Directors of a media company, for instance, could regularly ask its news executives to lead reviews of editorial standards.

Yet even the best systems will not identify all the risks, and boards and management must somehow try to grasp the unthinkable. The best way may be to tap into the concerns and observations of middle management, the group most

likely to be aware of bad practices or rogue behavior in any company. Boards have a duty to ensure that management teams pursue bottom-up investigations (through confidential questionnaires, for instance), identify key risk areas, and act on the results.

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Forward-looking boards must remain vigilant and energetic, always wary of bad habits. An objective 360-degree review, built on personal interviews, is generally a much better option than the box-ticking self-evaluation alternative. Winning boards will be those that work in the spirit of continuous improvement at every meeting, while always keeping long-term strategies top of mind. Only by creating more forward-looking boards can companies avoid the sort of failures witnessed during the last financial meltdown the next time one strikes.

The authors would like to acknowledge the contributions of Martina Bender and Nina Spielmann to the development of this article.

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Building a sense of purpose at Pixar

Ed Catmull

The cofounder of Pixar Animation Studios recalls how a serious organizational rift led him to a new sense of mission—and how it helped Pixar develop a more open and sustainable creative culture.

I wish I could bottle how it felt to come into work during those first heady days after *Toy Story* came out. People seemed to walk a little taller, they were so proud of what we'd done. We'd been the first to make a movie with computers, and—even better—audiences were touched deeply by the story we told. As my colleagues went about their work, every interaction was informed by a sense of pride and accomplishment. We had succeeded by holding true to our ideals; nothing could be better than that. The core team who had joined us in 1994 to edit *Toy Story* immediately moved on to *A Bug's Life*, our movie about the insect world. There was excitement in the air.

But while I could *feel* that euphoria, I was oddly unable to participate in it.

For 20 years, my life had been defined by the goal of making the first computer-graphics movie. Now that this goal had been reached, I had what I can only describe as a hollow, lost feeling. As a manager, I felt a troubling lack of purpose. *Now what?* The act of running a company was more than enough to keep me busy, but it wasn't *special*. Pixar was now successful, yet there was something unsatisfying about the prospect of merely keeping it running.

It took a serious and unexpected problem to give me a new sense of mission.

For all of my talk about the leaders of thriving companies who did stupid things because they'd failed to pay attention, I discovered that, during the making of *Toy Story*, I had completely missed something that was threatening to undo us. And I'd missed it even though I *thought* I'd been paying attention.

Throughout the making of the movie, I had seen my job, in large part, as minding the internal and external dynamics that could divert us from our goal. I was determined that Pixar not make the same mistakes I'd watched other Silicon Valley companies make. To that end, I'd made a point of being accessible to our employees, wandering into people's offices to check in and see what was going on. John Lasseter[1] and I had very conscientiously tried to make sure that everyone at Pixar had a voice, that every job and every employee was treated with respect. I truly believed that self-assessment and constructive criticism had to occur at all levels of a company, and I had tried my best to walk that talk.

Now, though, as we assembled the crew to work on *A Bug's Life*, I discovered we'd completely missed a serious, ongoing rift between our creative and production departments. In short, production managers told me that working on *Toy Story* had been a nightmare. They felt disrespected and marginalized—like second-class citizens. And while they were gratified by *Toy Story*'s success, they were very reluctant to sign on to work on another film at Pixar.

I was floored. How had we missed this?

The answer, at least in part, was rooted in the role production managers play in making our films. Production managers monitor the overall progress of the crew; they keep track of the thousands of shots; they evaluate how resources are being used; they persuade and cajole and nudge and say no when necessary. In other words, they do something essential for a company whose success relies on hitting deadlines and staying on budget: they manage people and safeguard the process.

If there was one thing we prided ourselves on at Pixar, it was making sure that Pixar's artists and technical people treated each other as equals, and I had assumed that same mutual respect would be afforded to those who managed the productions. I had assumed wrong. Sure enough, when I checked with the artists and technical staff, they *did* believe that production managers were second class

and that they impeded—not facilitated—good filmmaking by overcontrolling the process, by micromanaging. Production managers, the folks I consulted told me, were just sand in the gears.

My total ignorance of this dynamic caught me by surprise. My door had always been open! I'd assumed that would guarantee me a place in the loop, at least when it came to major sources of tension, like this. Not a single production manager had dropped by to express frustration or make a suggestion in the five years we worked on *Toy Story*. Why was that? It took some digging to figure it out.

First, since we didn't know what we were doing as we'd geared up to do *Toy Story*, we'd brought in experienced production managers from Los Angeles to help us get organized. They felt that their jobs were temporary and thus that their complaints would not be welcome. In their world—conventional Hollywood productions—freelancers came together to make a film, worked side by side for several months, and then scattered to the winds. Complaining tended to cost you future work opportunities, so they kept their mouths shut. It was only when asked to stay on at Pixar that they voiced their objections.

Second, despite their frustrations, the production managers felt that they were making history and that John was an inspired leader. *Toy Story* was a meaningful project to work on. The fact that the production managers liked so much of what they were doing allowed them to put up with the parts of the job they came to resent. This was a revelation to me: the good stuff was hiding the bad stuff. I realized that this was something I needed to look out for. When downsides coexist with upsides, as they often do, people are reluctant to explore what's bugging them, for fear of being labeled complainers. I also realized that this kind of thing, if left unaddressed, could fester and destroy Pixar.

For me, this discovery was bracing. Being on the lookout for problems, I realized, was not the same as *seeing* problems. This would be the idea—the challenge—around which I would build my new sense of purpose.

While I felt I now understood why we had failed to detect this problem, we still needed to understand what people were upset about. To that end, I started sticking my head into people's offices, pulling up a chair and asking them for their view on how Pixar was and wasn't working. These conversations were intentionally open ended. I didn't ask for a list of specific complaints. Bit by bit, conversation by conversation, I came to understand how we'd arrived in this thicket.

There had been a great deal riding on *Toy Story*, of course, and since making a film is extremely complicated, our production leaders had felt tremendous pressure to control the process—not just the budgets and schedules, but also the flow of information. If people went willy-nilly to anybody with their issues, the production leaders believed, the whole project could spiral out of control. So, to keep things on track, it was made clear to everyone from the get-go:

if you have something to say, it needs to be communicated through your direct manager. If animators wanted to talk to modelers, for example, they were required to go through "proper channels." The artists and technical people experienced this "everything goes through me" mentality as irritating and obstructionist. I think of it as well-intentioned micromanaging.

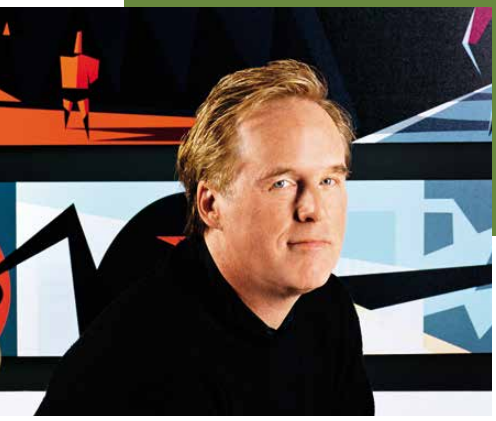
Because making a movie involves hundreds of people, a chain of command is essential. But in this case, we had made the mistake of confusing the communication structure with the organizational structure. Of course an animator should be able to talk to a modeler directly, without first talking with her manager. So we gathered the company together and said that going forward, anyone should be able to talk to anyone else, at any level, at any time, without fear of reprimand. Communication would no longer have to go through hierarchical channels. The exchange of information was key to our business, of course, but I believed that it could—and frequently should—happen out of order, without people getting bent out of shape. People talking directly to one another and then letting the manager find out later was more efficient than trying to make sure that everything happened in the "right" order and through the "proper" channels.

Improvement didn't happen overnight. But by the time we finished *A Bug's Life*, the production managers were no longer seen as impediments to creative progress but as peers—as first-class citizens. We had become better.

This was a success in itself, but it came with an added and unexpected benefit: the act of thinking about the problem and responding to it was invigorating and rewarding. We realized that our purpose was not merely to build a studio that made hit films but also to foster a creative culture that would continually ask questions. Questions like: If we had done some things right to achieve success, how could we ensure that we understood what those things were? Could we replicate them on our next projects? Was replication of success even the right thing to do? How many serious, potentially disastrous problems were lurking just out of sight and threatening to undo us? What, if anything, could we do to bring them to light? How much of our success was luck? What would happen to our egos if we continued to succeed? Would they grow so large they could hurt us and, if so, what could we do to address that overconfidence? What dynamics would arise now that we were bringing new people into a successful enterprise as opposed to a struggling start-up?

What had drawn me to science, all those years ago, was the search for understanding. Human interaction is far more complex than relativity or string theory, of course, but that only made it more interesting and important; it constantly challenged my presumptions. As we made more movies, I would learn that some of my beliefs about why and how Pixar had been successful were wrong. But one thing could not have been more plain: figuring out how to build a sustainable creative culture—one that didn't just pay lip service to the importance of things like honesty,

Brad Bird



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> "Making a film, you have all these different departments, and what you're trying to do is find a way to get them to put forth their creativity in a harmonious way. Otherwise, it's like you have an orchestra where everybody's playing their own music. Each individual piece might be beautiful, but together they're crazy."

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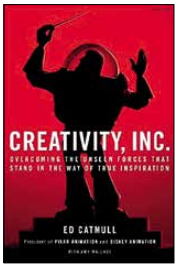
Brad Bird is the Academy Award–winning director of *The Incredibles* (2004) and *Ratatouille* (2007). For more about Pixar's creative culture, see our 2008 interview "Innovation lessons from Pixar: An interview with Oscar-winning director Brad Bird," on mckinsey.com.

excellence, communication, originality, and self-assessment but was really *committed* to them, no matter how uncomfortable that became—wasn't a singular assignment. It was a day-in, day-out full-time job. And one that I wanted to do.

As I saw it, our mandate was to foster a culture that would seek to keep our sight lines clear, even as we accepted that we were often trying to engage with and fix what we could not see. My hope was to make this culture so vigorous that it would survive when Pixar's founding members were long gone—a culture enabling the company to continue producing original films that made money, yes, but also contributed positively to the world. That sounds like a lofty goal, but it was there for all of us from the beginning. We were blessed with a remarkable group of employees who valued change, risk, and the unknown and who wanted to rethink how we create. How could we enable the talents of these people, keep them happy, and not let the inevitable complexities that come with any collaborative endeavor undo us along the way? That was the job I assigned myself, and the one that still animates me to this day.

[1]John Lasseter is chief creative officer of Walt Disney and Pixar Animation Studios.

Ed Catmull is cofounder and president of Pixar Animation Studios and president of Walt Disney Studios.



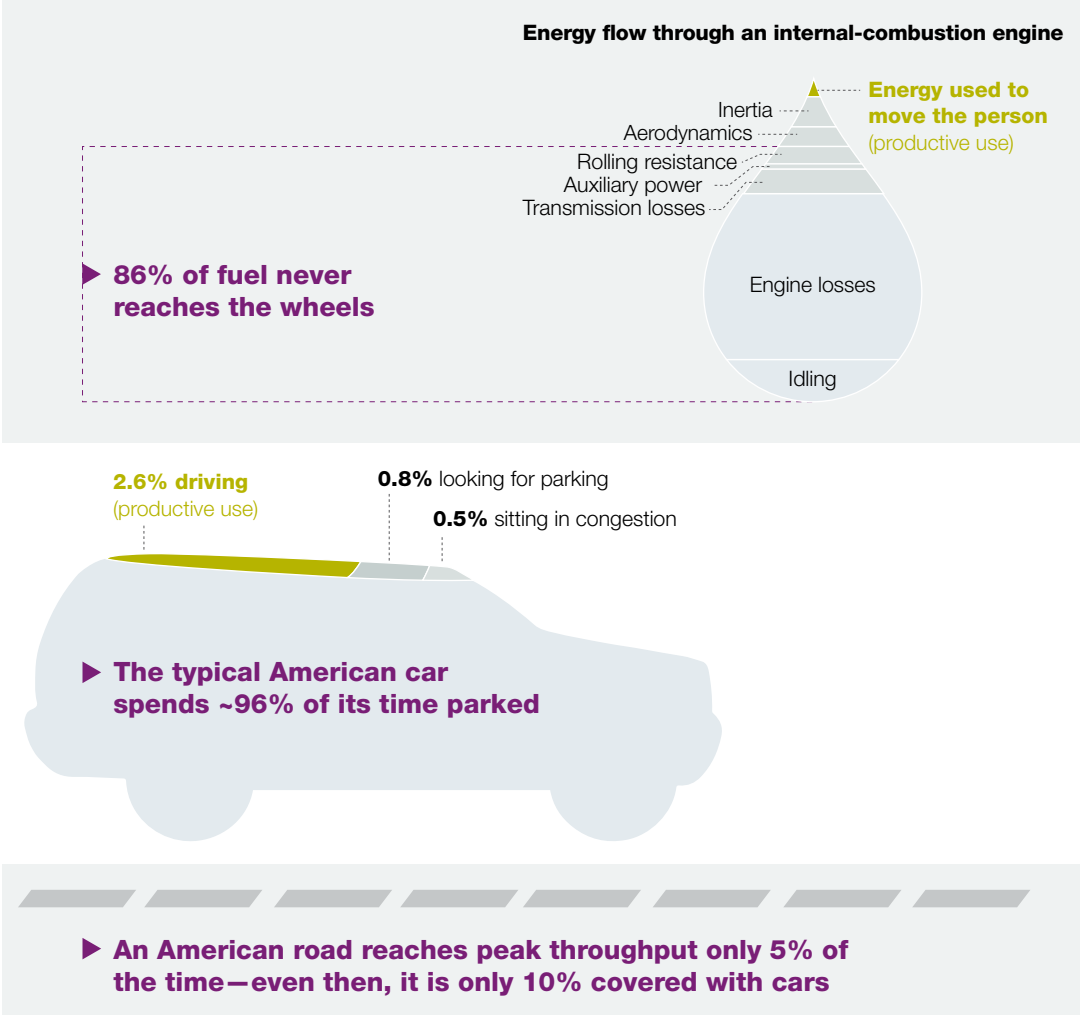
This article is excerpted from Ed Catmull's book, *Creativity, Inc: Overcoming the Unseen Forces That Stand in the Way of True Inspiration* (Random House, April 2014).

Extra Point

Time for a revolution

Stefan Heck and Matt Rogers

The quality and efficiency of automobiles have improved dramatically over the years, yet very little of the energy that fuels car engines ever reaches the wheels, cars are rarely in motion, and roads are poorly utilized, even during peak periods. These inefficiencies highlight the potential for a resource revolution that could revitalize the global economy.



Source: Amory B. Lovins and the Rocky Mountain Institute, *Reinventing Fire: Bold Energy Solutions for the New Energy Era*, White River Junction, VT: Chelsea Green Publishing, 2011; Wolfgang S. Homburger, James H. Kell, and David D. Perkins, *Fundamentals of Traffic Engineering*, 13th edition, Berkeley, CA: University of California, Berkeley, Institute of Transportation Studies, 1992

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For more, see "Are you ready for the resource revolution?," on page 32.

Highlights:

Are you ready for the resource revolution? New management approaches for a leap in resource productivity, the disruptive potential of solar power, and fresh insights from Daniel Yergin and the president of the Environmental Defense Fund

Next frontiers for lean—what's in store for lean production as big data and sensor technology redefine what it means to continuously improve operations. Plus, how Amazon went lean.

The hidden value of organizational health—and how to capture it

High-performing boards: What's on their agenda?

Change leader, change thyself—how individual self-awareness strengthens organizational change

Pixar's Ed Catmull on building a sense of purpose

Preparing for bigger, bolder shareholder activists

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