
*2016 industrial
manufacturing
trends*

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**Manufacturers
must weather the
risk that comes
with embracing
new technologies**

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About the authors

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Introduction

The sting of 2001 and 2008 is still too painful for some industrial manufacturing companies to forget. Back then, global economic expansion enticed industrial manufacturers to invest in new equipment and technologies designed to improve factory performance for themselves and their customers. When markets unexpectedly crashed, they paid a steep price for having bought at the top of the cycle. The payoff took years to realize, if it appeared at all.

This recollection colors the tentative steps that many industrial manufacturing companies are taking today. Indeed, economic growth, although occurring, isn't particularly robust. It's anybody's guess whether China is heading for a soft landing or a renewed takeoff. The Eurozone's future and the prospects for Brazil, India, and Russia are impossible to read. It's tempting to believe that a boardroom version of "the prevent defense" — avoiding possible big losses by taking few chances — may be the best strategy.

But that conclusion is a false choice. Manufacturing may be facing some headwinds, but it's undeniably in the midst of a technological renaissance that is transforming the look, systems, and processes of the modern factory. Despite the risks — and despite recent history — industrial manufacturing companies cannot afford to ignore these advances. By embracing them now, they can improve productivity in their own plants, compete against rivals, and maintain an edge with customers who are seeking their own gains from innovation.

Rather than fearing the past, industrial manufacturing executives should be asking these critical questions: At a time of rapid change and limited upside, which technology investments will have the biggest positive impact on my business? And what is the value potential, return on investment, and risk of investing in these technologies?

Manufacturers must embrace technological advances to improve plant productivity, compete against rivals, and maintain an edge with customers.

Technological transformation

Given today's leading-edge capabilities, it's reasonable to envision — and prepare for — a data-driven factory of the future where all internal and external activities are connected through the same information platform. Customers, designers, and operators will share information on everything from initial concepts, to installation, to performance feedback throughout the life cycle. Operators will access materials on demand, collaborate with robots to use them safely and ergonomically, and rely on virtual work instructions presented at the point of use. Assembly lines will output highly personalized products, sometimes in a lot size of one, that contain zero defects.

But what breakthrough equipment, ideas, and processes will have the greatest impact on factory environments? The following four technology categories are already driving much of the change.

- **Internet of Things (IoT):** The connected factory is an idea that has been evolving for the past few years. Increasingly, it means expanding the power of the Web to link machines, sensors, computers, and humans in order to enable new levels of information monitoring, collection, processing, and analysis. These devices provide more precision and can translate collected data into insights that, for example, help to determine the amount of voltage used to produce a product or to better understand how temperature, pressure, and humidity impact performance. Stanley Black & Decker has adapted the Internet of Things in a plant in Mexico to monitor the status of production lines in real time via mobile devices and Wi-Fi RFID tags. As a result, overall equipment effectiveness has increased by 24 percent, labor utilization by 10 percent, and throughput by 10 percent.

But for industrial manufacturing companies, the next generation of IoT technology should go well beyond real-time monitoring to connected information platforms that leverage data and advanced analytics to deliver higher-quality, more durable, and more reliable products. A hint of this can be seen in wind turbines manufactured by General Electric. This equipment contains some 20,000 sensors

that produce 400 data points per second. Immediate, ongoing analysis of this data allows GE and its customers to optimize turbine performance and proactively make decisions about maintenance and parts replacement.

Before investing in IoT, however, industrial manufacturing companies must determine precisely what data is most valuable to collect, as well as gauge the efficacy of the analytical structures that will be used to assess the data. In addition, next-generation equipment will require a next-generation mix of workers, which should include employees who can design and build IoT products as well as data scientists who can analyze output.

- **Robotics:** Over the last decade, China emerged as an automated manufacturing powerhouse, as increased labor costs and booming industrial demand drove tremendous growth in industrial robotics. Since 2013, the number of shipments of multipurpose industrial robots in China roughly doubled to an estimated 75,000 in 2015, with that number forecast to double yet again to 150,000 by 2018, according to the International Federation of Robotics. Yet although a Chinese company recently broke ground on the world's first fully automated factory, in Dongguan, the widespread use of robotics and unmanned control technologies may not address all productivity concerns. Indeed, some manufacturers believe that greater automation is harmful, resulting in less innovation because only people can develop ideas to improve processes and products. Consequently, robotic implementation is evolving on a different path in the U.S. and other mature economies. In many cases, robots are employed to complement rather than replace workers. This concept, known as "cobotics," teams operators and machines in order to make complex parts of the assembly process faster, easier, and safer.

Cobotics is rapidly gaining momentum, and successful implementations to date have focused largely on specific ergonomically challenging tasks within the aerospace and automotive industries. But these applications will expand as automation developers introduce more sophisticated sensors and more adaptable, highly functional robotic equipment that will let humans and machines interact deftly on the factory floor.

- **Augmented reality:** Recent advances in computer vision, computer science, information technology, and engineering have enabled manufacturers to deliver real-time information and guidance at the point of use. Users simply follow the text, graphics, audio, and other virtual enhancements superimposed

onto goggles or real assemblies as they perform complex tasks on the factory floor. These tools can simultaneously assess the accuracy and timing of these tasks, and notify the operator of quality risks.

Some industrial manufacturing companies are using this technology to provide hands-free training, enable faster responses to maintenance requests, track inventory, increase safety, and provide a real-time view of manufacturing operations. In more than a few instances, these added services could be sold as add-ons to the equipment itself, creating a new revenue stream for industrial manufacturing firms. Among the possible applications is an assembly-line instructional feature in which video clips or text instructions walk workers through complex processes step-by-step. Mistakes resulting from fatigue or on-the-job pressure are eliminated. Another possibility involves using data and physical evidence retrieved by augmented reality on the factory floor to design new equipment that addresses the shortcomings of present-day devices on the assembly line.

- **3D printing:** Also known as additive manufacturing, 3D printing technology produces solid objects from digital designs by building up multiple layers of plastic, resin, or other materials in a precisely determined shape. Early adopters among industrial manufacturing companies are using 3D printing to manufacture parts in small lots for product prototypes, to reduce design-to-manufacturing cycle times, and to dramatically alter the economics of production. For example, BAE Systems turned to 3D printing when it could no longer secure a critical injection-molded plastic part for a regional jetliner. The company saved more than 60 percent on the cost of the part, avoided retooling costs, and shrank production lead times by two months.

3D printing is still in its infancy, and the technology is currently limited in the performance specifications of the products it can produce. But companies must begin planning for the incorporation of this technology now. As an initial step, industrial manufacturing companies should apply 3D printing technology to the product development and prototyping process, where its speed and flexibility can spur innovation and reduce time-to-market. The next step could be to use 3D printing to make highly specialized, low-volume parts that are components or subassemblies of finished products, or to create tools for the molding, casting, or forming of products.

Industrial manufacturers should apply 3D printing technology to product development and prototyping to spur innovation and reduce time-to-market.

New risk and reward equation

In our view, industrial manufacturing executives should consider investments in emerging technologies through three paths of analysis:

1. **Determine the specific areas to improve in your organization, or what performance target a technology investment is trying to achieve.** How will the investment impact cost, quality, labor, or other strategic concerns? How will the new technology help differentiate the value you provide to customers? Will it create capacity or generate productivity in the constrained parts of your operations? Will the technology provide increased flexibility to help you deal with uncertainty?
2. **Understand how the new technologies will enable that level of performance — and weigh the value of achieving that performance against the cost of the technology.** What level of output should the facility be able to create today, and how much improvement can be expected over time as the technology continues to evolve? Who are the current industry leaders in each technology category, and what tangible impact is their technology having? What is the clock speed of the technology, and how feasible is it that it will evolve to reliably deliver on the performance goals?
3. **Understand the operational and organizational implications of the technology and how it aligns with the factory of the future vision.** How does it help or hurt operators or the culture? How should teaming and incentives models evolve to optimize new technology? How scalable is the technology? How well does it integrate into a company's technology backbone and global footprint?

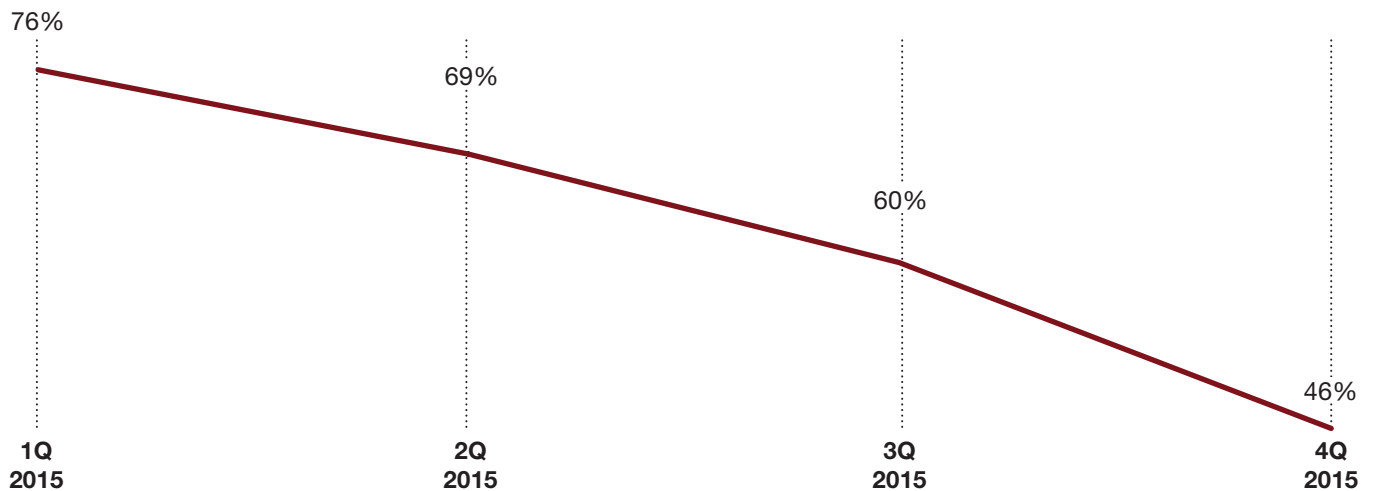
Although the emerging technologies are potentially transformative, they are unfolding against a backdrop of uncertainty among industrial manufacturing companies. In the fourth-quarter 2015 PwC Manufacturing Barometer™, which surveys U.S.-based industrial manufacturing executives, only 27 percent of industrial manufacturing CEOs expressed optimism about the global economy. Industrial manufacturers' estimated mean revenue growth, moreover, declined

to 1.8 percent in 2015, from 5.2 percent in the prior year, according to this report. Worse yet, just 31 percent of companies are operating near full capacity in the fourth quarter, a decline of 26 percentage points in the past 12 months.

Still, this data should be viewed as the springboard for calculated action. Rapid factory innovation is altering the risk/reward equation. A timid response to seemingly tepid economic conditions can quickly place businesses in jeopardy — behind competitors and unable to address customer needs — even as markets improve in the coming years. We've found that making strategic investments is essential for growth, particularly in fast-evolving industries. Given that manufacturing technology is evolving faster than ever before, many of the technologies being introduced today will be commonplace within five or 10 years. Industrial products executives must lead with an eye toward that reality, and not merely the current bottom line.

Pessimism among industrial manufacturing CEOs...

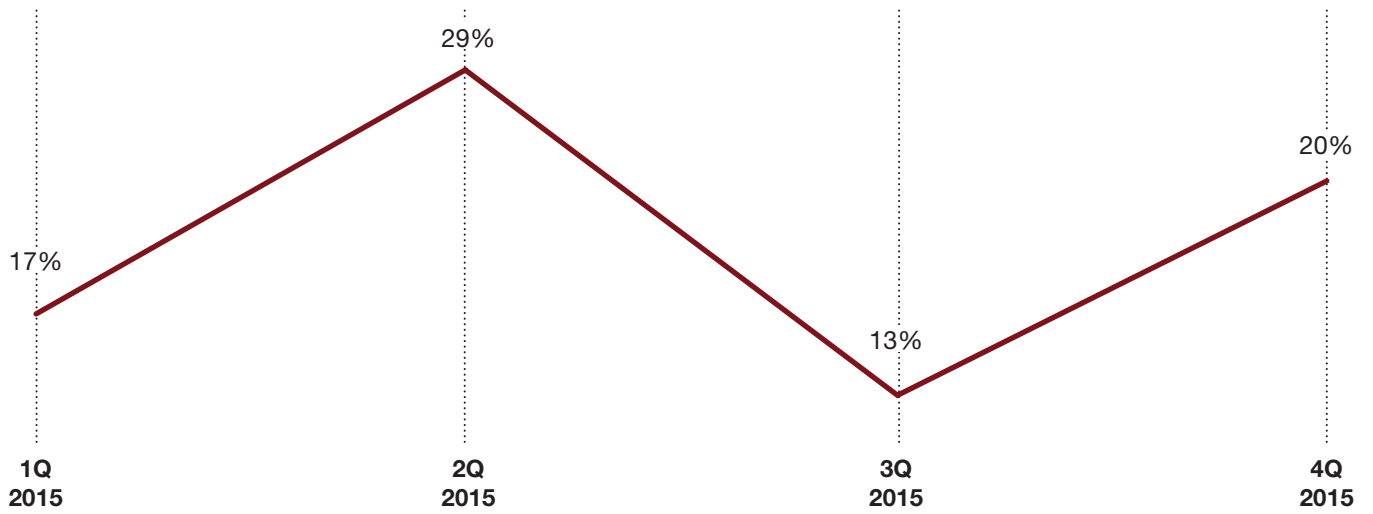
Percent optimistic about U.S. economy for next 12 months



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Is reflected in fewer new strategic alliances...

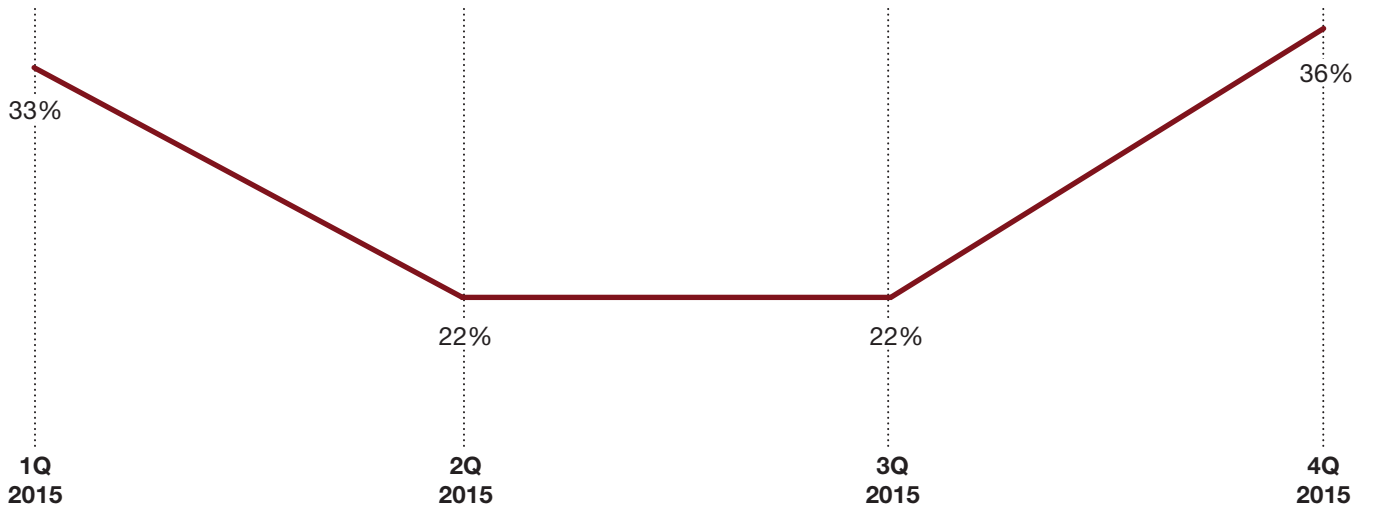
Plans for strategic alliances in the next 12 months



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And stagnant spending on information technology.

Percent planning to increase IT spending in next 12 months



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