strategy&

Manufacturing's new world order

&

The rise of the point-of-demand model

pwc

Contacts

Chicago

Eric Dustman
Principal, PwC US
+1-847-269-4758
eric.dustman@pwc.com

Detroit

Rajiv Jetli
Principal, PwC US
+1-313-394-3132
rajiv.jetli@pwc.com

Düsseldorf

Andreas Eggert
Managing Director, PwC Strategy& Germany
+49-211-3890-334
andreas.eggert
@pwc.com

Bernd Jung
Partner, PwC Strategy& Germany
+49-211-3890-402
bernd.jung@pwc.com

Alexia Spieler
Manager, PwC Strategy& Germany
+49-151-5713-2103
alexia.spieler@pwc.com

Melbourne

Ben Gilbertson
Partner, PwC Australia
+61-3-8603-0928
ben.gilbertson@pwc.com

About the authors

Andreas Eggert is a managing director in the operations strategy practice at PwC Strategy& Germany. He works across a broad array of industries including healthcare, chemicals, consumer products and retail, and industrial products, specializing in restructuring and transformation as well as supply chain management strategies such as lean operations, network transformation, and organization. He is based in Düsseldorf.

Rajiv Jetli is an advisor to executives in the industrial products and automotive sectors at Strategy&, PwC's strategy consulting business. Based in Detroit, he is a principal with PwC US. With more than 25 years of experience in operations, strategy, supply chain management, and procurement in the manufacturing industry, he has worked with clients on operations improvement programs as well as due diligence of operations for private equity firms.

Alexia Spieler is a manager with PwC Strategy& Germany. She is based in Düsseldorf, where she specializes in growth strategy, manufacturing footprint, and complexity management, especially for the industrial products and automotive sectors. She has worked with clients across Europe, North America, and Asia.

Hans Kuehn is a former partner in the industrial products practice at PwC Strategy& Germany.

Executive summary

In the next manufacturing revolution, spurred on by technologies that reinvent the way a factory can create products, such as 3D printing and robotics, companies will also need to rethink what they make and where they make it. Products will come off the assembly line in small, highly customized batches, like a high-tech version of old-fashioned craftsmanship. The revolution is on its way, and within the next five to 10 years, manufacturers in all industries will find themselves in a race to efficiently produce products at the point of demand — that is, where their customers are — and to deliver these items when their customers want them, personalized to their customers' individual tastes. They will have to make strategic choices to stay competitive, investing in technology that allows them to continually analyze data about their customers' preferences and buying habits so they can adapt quickly to changes in market conditions. Factories will be smaller, operating with minimal lead times and shorter value chains. Management will be decentralized, the supply chain will be simplified and shortened, and the distance separating the manufacturer from its customers will be sharply reduced.

Although technology will enable this new manufacturing model, customers will compel its adoption. In emerging markets as well as developed regions, customers increasingly expect products that match local cultural preference rather than homogeneous global brands and business-to-business services. The auto industry pioneered this localized model as long ago as the 1980s, when Japanese automakers entered the U.S. market with cars tailored to American tastes. But only recently have other industries taken up this approach — with refrigerators, toothpaste, furniture, clothing, and software that are designed for each region. The popularity of e-commerce has changed the customer experience, giving people more information about products and competitors' products, pricing, and, through peer reviews, quality. For the first time, customers can reasonably demand from mass producers products that look and feel like they were made next door.

Nimble manufacturers will reap significant gains from the point-of-demand model. As their supply systems become more responsive and as local customer demand becomes less of a guessing game, inventory inefficiencies and the carrying costs of having to warehouse products in bulk will decline. The expense of supply chain management and production planning will drop as well. And companies able to produce personalized products that are best suited to customer needs when customers want them will enjoy higher sales margins. By contrast, as point-of-demand manufacturing takes hold, companies that operate global factory networks with large centralized plants, managed by traditional operating systems, organizations, and processes, may find that their business models are outmoded.

Think globally, manufacture locally

A small U.S. startup called Local Motors offers an intriguing glimpse into the future of manufacturing. The company manages five so-called microfactories around the world, which primarily use 3D-printing equipment to produce such modern-day curios as Olli, a self-driving shuttle bus with IBM Watson artificial intelligence that can be hailed via a smartphone app and follows voice instructions; a cargo-carrying drone for Airbus dubbed the Zelator; and the world's first 3D-printed car, the Strati — road-worthy if not a speedster — built live in 44 hours at the International Manufacturing Technology Show.

But the 3D-printing aspect of Local Motors' business model is just a small part of what makes this company worth examining. The company is also crowdsourcing production designs from a network of global participants, who post their ideas in open forums for group consumption. The winning designer — in the case of Olli, a 24-year-old Colombian who had never crafted an industrial product before — is given a small cash prize and royalties on sales as well as the chance to continue to work and learn within Local Motors' manufacturing community.

Local Motors' production footprint plans are compelling as well. As the microfactory concept evolves, Local Motors will build new plants wherever its customers are located, and each manufactured item will effectively be one of a kind, built to suit the tastes and requirements of individual consumers. Scale is replaced by potential savings from engineering, design, parts, labor, and efficiency in a 3D microfactory. Local Motors describes this approach as making money from scope. In other words, it offers useful, attractive, bespoke products to customers who are within shouting distance of its factories, at a price that matches the distinctive value of the item.

Local Motors is still a nascent business — and may or may not ultimately succeed — but at its core it reflects a vital shift in production dogma that manufacturers of all sizes will have to reckon with in the coming years. After decades of chasing lower production costs and scale by extending factory footprints and supply chains deeper into emerging

nations and distributing products around the world in huge quantities over complex logistics networks, manufacturers are finding that their globalized approach is losing its viability. In particular, their centralized management structure, lengthy supply chains, lack of product variety, and long shipping times are impeding regional agility — and, in some cases, placing them at a disadvantage to local competition.

Instead, the new strategic archetype for successful manufacturers will be based on a relatively simple idea: The most efficient manufacturing setup is the one that makes goods in appropriate volumes to meet demand at the point of demand, with plenty of room for local and individual customization. Much of this concept will be driven by advances in technology — 3D printing, factory innovations, e-commerce, data analytics, and the Internet of Things, to name a few — which will allow companies to take advantage of customer interest, a growing middle class in emerging regions, and demand for specific items no matter how quickly the demand shifts. Some products will be more personalized than others, but overall the distance separating the manufacturer from its customers will be sharply diminished in favor of improved product quality, rapid market response, smaller factories, minimal lead times, better supply chain coordination, and decentralized management.

The most efficient setup is the one that makes goods to meet demand at the point of demand.

Moreover, the impact of the point-of-demand model will not be limited to the business-to-consumer environment. Suppliers in the business-to-business realm will also be under pressure to improve responsiveness as part of the campaign by their customers — that is, manufacturers — to shorten the value chain and more proactively serve the end consumer.

The implications are problematic for some companies: Manufacturers that are today highly invested in a global factory network of multiple large centralized plants, managed by traditional operating systems, organizations, and processes, may find their business models becoming obsolete faster than they ever expected. However, the nimblest manufacturers stand to reap significant gains from this new model. As their supply systems become more responsive and as customer demand becomes less of a guessing game, inventory inefficiencies and the carrying costs of warehousing products in bulk — only to ultimately jettison some of them as dead stock — will decline. In addition, savings will be generated by the reduction in expensive long-range production planning and supply chain management. And for companies able to outpace rivals in producing products that are best suited to customer needs — making these items available when customers want them — sales margins should rise markedly.

Changes in attitude

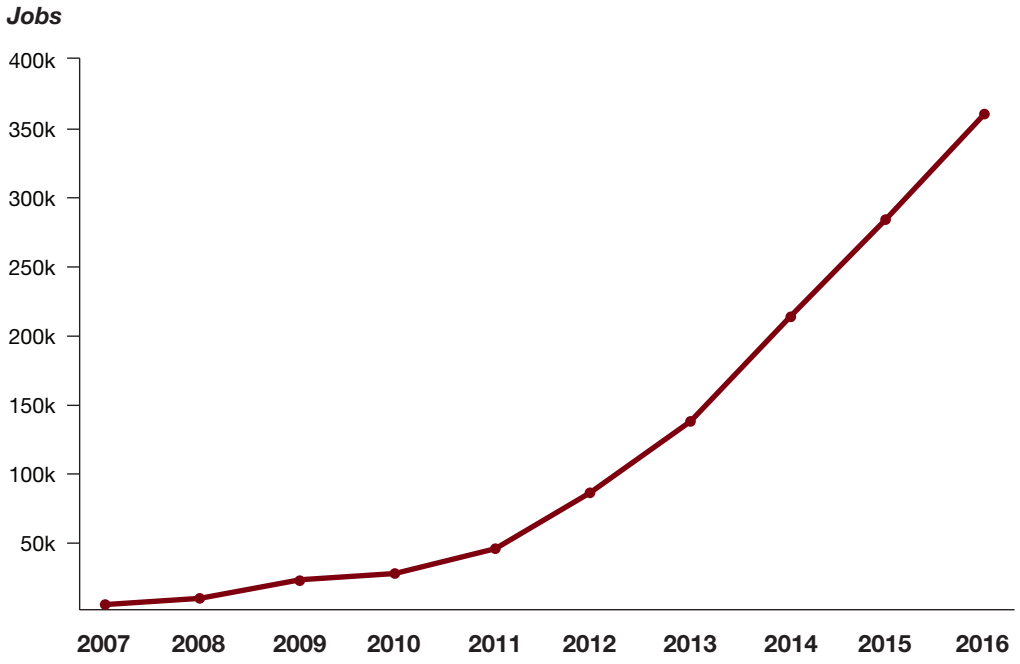
The globalization manufacturing paradigms of the past few decades were primarily cost-cutting ventures built on traditional high-volume production schemes. Locating factories in regional hubs, typically in developing countries outside a manufacturer's domestic market, was seen as a way to reduce labor expenses and form alliances with low-cost suppliers in these regions. And as long as the discount to operate in emerging nations was large enough to overcome logistics inefficiencies and time-to-market requirements, this approach was profitable and made perfect sense.

But a combination of trends is making this strategic approach obsolete — and is shifting value creation in production downstream toward customers and customization. For one thing, wage escalation in emerging nations and concerns about uncertain energy costs have eroded the perceived competitive advantage that multinationals sought from offshoring. As a result, many large industrial companies shifted gears, choosing to reshore back into large home markets in the U.S. and Europe rather than make items elsewhere and ship them in. Since 2010 — when U.S. manufacturing employment hit a modern-day low — more than 338,000 American jobs have been added through reshoring or foreign direct investment (FDI) by companies that formerly supplied goods to U.S. manufacturers from overseas (*see Exhibit 1, next page*).

More recently, political currents have influenced some multinational manufacturing footprint and supply chain decisions. Protectionist sentiments expressed by new administrations in the United States and the United Kingdom are symptoms of a slowdown in global trade that has quietly taken hold over the past few years. Part of the reason for this weakness is a deceleration in trade liberalization and increasing concerns about currency volatility and new tariffs or other trade-based taxes. Given these developments, making items where they will be sold is a more economically viable option, already being embraced. For example, facing rising expenses as the value of the pound sterling plummeted after the Brexit vote, U.K. food companies began to shift toward local suppliers in an effort to keep costs down. And addressing the growing importance of the "build where you sell" principle in the

Exhibit 1

Reshored and FDI manufacturing jobs, cumulative adjusted 2007–15



Source: Reshoring Initiative (used by permission)

auto industry, Carlos Ghosn, CEO of Renault-Nissan, told Reuters, "There is no doubt we need to adapt."

More than anything, however, the rapidly morphing relationship between manufacturers and their consumers is at the heart of the point-of-demand revolution — and will have the most permanent impact on it. In all regions, but particularly in emerging nations as demand evolves and the middle class expands, customers increasingly expect products that match local cultural preferences, rather than homogeneous global brands and business-to-business services.

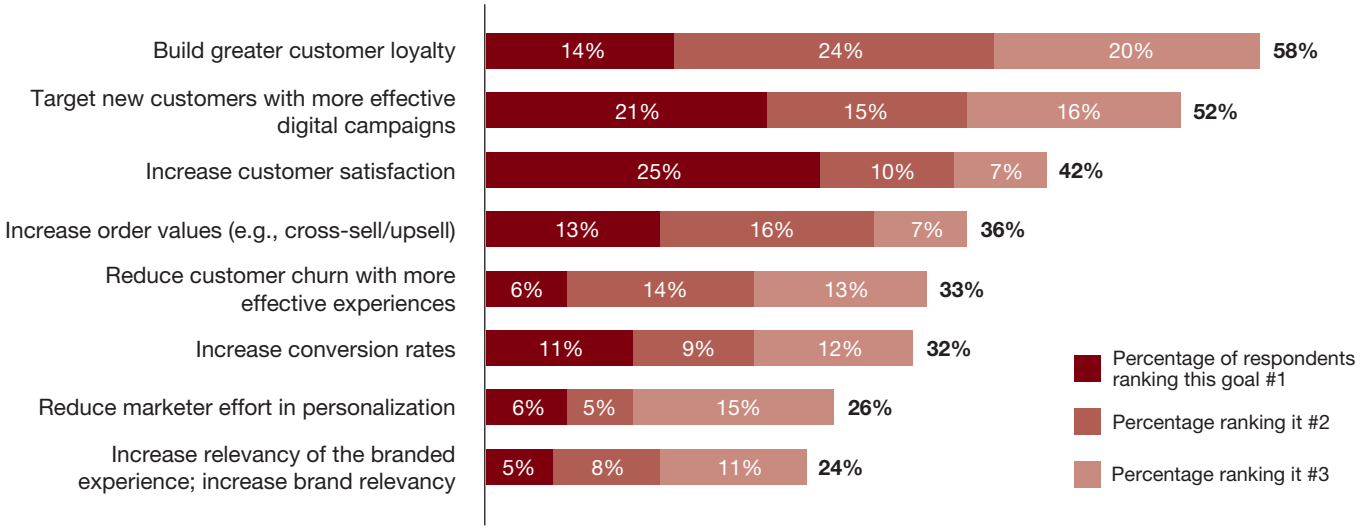
A recent Nielsen survey of 30,000 consumers in 61 countries found that three-quarters of respondents made purchases based primarily on whether the product was manufactured locally. This was especially true of residents in Asia-Pacific, Africa, and the Middle East. Research at global companies has turned up the same sentiment, which has precipitated a burst of product customization; everything from refrigerators to toothpaste, potato chips to software, is being redesigned for individual regions. E-commerce and its many offshoots involving simpler and more transparent transactions on the mobile Web have especially transformed the customer experience, empowering purchasers with more information about products and possible competitors' products, pricing, and, through peer reviews, quality. For the first time, customers can reasonably demand products from mainstream manufacturers that look and feel like they were made next door. And companies can expect increased customer loyalty when they meet these demands through personalization (*see Exhibit 2, next page*).

Customers increasingly expect products that match local cultural preferences.

Exhibit 2

Primary goals of personalization

"What are the primary goals of your organization's personalization investments and initiatives?"



Base: 101 U.S. enterprise decision makers responsible for personalization technology at their organization

Source: "The Power of Personalization," Dec. 2015, a commissioned study conducted by Forrester Consulting on behalf of PwC

Enabled by technology

Certainly the economic and consumer trends that have made point-of-sale manufacturing inevitable are powerful forces on their own. But they would have no impact — or at least companies would not be able to have an orchestrated response to them — were it not for the equally striking breakthroughs in technology that are at the heart of point-of-demand production and amplify its potential.

This array of new technologies is drastically shortening supply chains and the route that products take from factory to consumer, and making low-volume production and product customization more economically viable. Although still in its infancy, the technology is already profoundly altering the manufacturing landscape, opening up markets for even small competitors to enter, providing new ways to build higher-quality personalized products for customers more efficiently and at lower cost, and compelling established companies to adopt a sustainable localized set of manufacturing capabilities and innovative production models. The technology advances that manufacturers should explore to implement a point-of-demand framework can be divided into the following categories:

Customer-centric software. In its simplest form, this category can best be illustrated by Apple's development and global rollout of the iPhone. By treating the phone itself as just a generic piece of hardware that can be personalized and continually updated by programs and apps to match the preferences of individual users, Apple is betting that the sustainable value of its product will be in the customized software. In a real sense, each iPhone owner assembles his or her own finished product, enhancing an Apple-provided platform with third-party elements uniquely targeted, region by region, for user personalization.

Apple's approach, which other communications and computer companies have also adopted, is a relatively basic customer-centric point-of-demand application — and barely touches the surface of what is possible in the software arena. For something more futuristic but no less probable as a point-of-demand concept, consider the implications of using blockchain technology in manufacturing. (Blockchain is a

software mechanism already common in financial services for permitting secure peer-to-peer interactions without the need for a third-party intermediary to log and authenticate the transaction.) Embedding this technology in the production sphere would allow manufacturers, suppliers, and customers to find each other instantly via blockchain networks and begin a digital trading relationship based on filling an immediate demand for one or even 100,000 items. Suppliers and manufacturers — in some cases, multiple producers — able to meet the tight schedule would collaborate to fulfill the customer's needs.

Digital factory. Fully digitized factories, powered by advances in production hardware and software, can simplify and minimize supply chains by localizing and automating manufacturing processes and footprints. Because these factories are highly automated and rely heavily on technology, they are essentially templates for virtually turnkey new plants that can be quickly dropped into any region. The dependence on automation also reduces the need for local skilled labor and training and ensures quality consistency. And as manufacturers shift more value to these local factories, increasingly greater flexibility and product customization are possible.

Fully digitized factories can simplify and minimize supply chains.

A version of the digital factory was behind a production plan implemented by a U.S. industrial devices manufacturer, which hoped to better meet the needs of the short project planning cycles favored by customers in China, Africa, and the Middle East. The company had learned that because these customers gave themselves limited up-front time before launching new factory projects, they were inclined to purchase any available industrial machine equipment that fit their plant needs, regardless of brand. To take advantage of this finding — which suggested that the industrial equipment manufacturer could notably increase market share in these regions by trimming just two weeks off lead times for product deliveries — the company developed a program to build stripped-down versions of its equipment in the U.S. and use networked computer-aided design and digital engineering tools to manage the finishing work — such as adding bolt-on parts or locally favored options — at customization centers closer to its emerging market customers.

The potential value of the digital factory and digital point-of-demand manufacturing can be amplified with sophisticated analytics to assess the volumes of data that companies amass these days about the demand for their products by region; how customers use their products; inventory levels; product performance through sensors embedded in items made in the B2B realm; and supply chain activities. These analyses could be seen as windows into the production and supply chain process and its ability to respond to consumer needs. As such, this valuable digital cache — sometimes called smart visualization —

can be the starting point for maximizing a flexible manufacturing footprint based on dynamic choices about production in response to changing demand by location.

The pharmaceuticals industry is among the first to actively investigate ways to take advantage of the combination of data analytics and digitized factories. At least one large drugmaker and a raft of pharmaceutical research teams are developing methods for using smart visualization to quickly build portable manufacturing suites that can customize products for specific regions. Although the initial instant factories are still in trial phases or awaiting regulatory approval, pharmaceutical firms hope this approach will reduce stockouts, better address local needs, and minimize plant downtime. In a similar application, Siemens has combined smart visualization with simulation software to digitally fine-tune plant engineering, quality control, capacity utilization, equipment performance, automation, and production flows before building factories for its industrial clientele. With this simulated blueprint, Siemens is able to help its customers set up cost-effective and high-performance point-of-demand plants quickly, customized by the type and volume of output and other regional necessities.

Manufacturing innovation. Perhaps the most iconic new manufacturing approach in decades is 3D printing, which places production of small or large parts and finished products directly into factories located anywhere, without having to worry about shipping them there. With 3D printing — also known as additive production because it involves making products through building up component layers in three dimensions — the value added by the manufacturing process is compressed into the local manufacturing activity. As a result, an automaker adopting an additive production program would not have to wait weeks for a supplier to produce and deliver a new headlamp with a specialized shape chosen by a customer, but could instead make it in minutes on a 3D printer. The result for manufacturers is the ability to offer a flexible response to customer demands and to be more adventurous about product design and personalization.

The relatively basic 3D-printing applications used by industry today barely tap the surface of how additive production will influence (and in many ways lead) the point-of-demand revolution. In a paper prepared for the International Academy for Production Engineering's Intelligent Computation in Manufacturing Engineering conference in 2015, three European academics posited the idea of cloud production as the inevitable outcome of 3D printing. In this scenario, suppliers no longer would make physical products but instead would sell customized product data to manufacturers, which would produce the items in distributed, localized factories using 3D printers.

Strategic framework

With the ground shifting quickly in manufacturing, companies will need to be agile to adjust to the changes and find their best path to more customer-oriented, efficient production models. In our view, manufacturers of all types will have to reexamine their value chains and determine which combination of the following three production strategies to adopt to take advantage of the benefits and respond to the competitive imperatives of the point-of-demand environment.

1. Product customization. As mass manufacturing gives way to custom production, many companies are only tentatively moving toward adoption of this new approach. In its least daring form, product personalization is given lip service when standard items are configured at point of demand based on actual customer orders. This model, which usually involves minimal customization of a limited set of standard products — for instance, six colors available for a guitar or a smartphone case — is relatively commonplace in many industries. Because of its timid offerings, it affords companies few of the actual potential gains from more aggressive point-of-demand production.

A more desirable approach for producers now would be to at least become a full-fledged product configurator by offering customers a wide range of options, not just a few, for relatively robust on-demand manufacturing. A slew of companies are beginning to stretch this idea in intriguing ways. For instance, the athletic shoe maker Adidas has recently built what it calls speedfactories in Germany and the United States, fully staffed by robots and able to rapidly personalize sneakers by dozens of possible options, including colors, laces, material, foot support, monograms, and logos. A study published by IOPscience on prospects for mass customization in Indonesia found that in 2014 there were already 470 Web-based product configurators offered by German companies, 332 more by U.S. outfits, and about 200 by businesses in other countries.

But this, too, is not fully customized manufacturing, which is the ultimate goal of point-of-demand production, since individuals cannot completely design their purchases. So far, only a few companies —

many of them, like Local Motors, making products in low volume — have become aggressive early adopters in this far-reaching manufacturing area. To do that and become true point-of-demand players, manufacturers will have to totally revamp and reimagine their product production and design processes. As production evolves to become smaller, with less overhead and more efficiencies, it will be possible to realize the goal of turning out such things as customized automobiles that can sell at mass-market prices.

2. Technology-driven production. The technology that will propel point-of-demand manufacturing covers a broad swath of possible applications including factory simulation, sensors, cloud-based programs, the Internet of Things, and 3D printing. But the engine that will drive all of these applications will be sophisticated and carefully designed data systems that can generate deep analyses to support efficient product personalization and anticipate customer preferences. In a point-of-demand production environment, company networks must have the ability to connect with tens of thousands of customers instantly, capturing their orders and requirements, whether for a single item or an ongoing series of on-time deliveries, in an automated fashion. From there, this data must flow directly into the production system with automated throughput processes that begin production immediately.

The engine that will drive all of these applications will be sophisticated data systems.

The goal, according to Siemens CEO Joe Kaeser, is to use customer data analytics — such as predictive programs to be prepared for what customers want, tracking past purchases and specific preferences, and sensors that help maintain products already out in the field — as tools for optimizing the value chain. As Kaeser put it: "The information you get from data can shorten [the] value chain. You can make products faster, more cost-efficiently, more flexibly. You can produce in lot sizes of one. You can cut out different links of the value chain. And the links that get cut out provide the least value in the value chain."

3. Lean manufacturing redux. The basic lean principles still have significant value in the point-of-demand manufacturing universe, but new technologies must be used to enhance lean methods and outcomes. In the new environment, manufacturing and supply chain flexibility and modular product design are essential, challenging the traditional lean advantages of economies of scale. To counter potential inefficiencies that could be introduced by one-off or at least low-volume manufacturing, breakthroughs in data analytics, sensors, robotics, networking, manufacturing equipment (including but not limited to 3D printing), and cloud programming should stimulate new personalized manufacturing processes and systems that support lean concepts involving quality, efficiency, factory performance, and productivity.

One lean area that will surely be tested by point-of-demand manufacturing involves the role of people in the factory. Traditionally lean approaches are aimed at eliminating waste and process variation by changing and optimizing processes and by standardizing human behavior and routines in plants. This type of thinking will become obsolete as robotic process automation — particularly software-based activities like design, engineering, or information processing — can tolerate some inefficiency because its vast computing power is able to overcome small degrees of waste or is more efficient to begin with. In other words, in a robotic factory, process variation — a critical lean target — will be eliminated by the nature of process automation.

However, even in this new lean scenario, the human element will be essential at the upper reaches of the value chain. Precisely because point-of-demand manufacturing is so reliant on personalization within an efficient production system, human intelligence will be imperative to design new, untried processes, manage their implementation, and oversee their continuous improvement — even as the real laborers will give over more and more of the repetitive tasks to robotics and artificial intelligence. The competitive edge in the point-of-demand factory will be enjoyed by manufacturers that are able to creatively use lean principles to drive efficiency in a new direction: Beyond just productivity improvements in repetitive tasks, the success of the point-of-demand environment depends on manufacturing processes achieving a higher degree of product flexibility and personalization, order by order. In this scenario, human talent should be employed to constantly enhance, fine-tune, and innovate customization and agile responses to simple or complex customer requirements.

Conclusion

Companies have intuitively known for many years that product personalization was an inevitable progression of modern manufacturing. Indeed, the concept of mass customization, which has been around for a few decades, is an early, even primitive, attempt to implement a more personalized manufacturing and service environment and respond better to customers. A car owner could customize a vehicle to a certain extent by choosing such features as colors, engine size, and transmission type, for example. The system wasn't very sophisticated, but because technology had not quite caught up with the ambitions for personalization, manufacturers could dabble in mass customization without a full commitment to a new production paradigm.

That's no longer the case. Technological advances and digital developments are emerging and spreading throughout the manufacturing environment so quickly that point-of-demand production is inevitable in virtually every industry; indeed, it's already being implemented. Eventually this will lead to cars made by companies like Local Motors — but also Toyota, Honda, and GM — being self-designed by adventurous consumers and built on 3D printers. And as customers taste the benefits of real product personalization, they will demand more of it, driving higher margins to companies that are equipped for customization and forcing all manufacturers to develop those capabilities if they hope to survive. In the end, companies that are prepared for the point-of-demand manufacturing phenomenon will thrive. But they must begin now to rethink their long-term manufacturing strategies and to implement the processes, systems, and technologies that will completely alter the way they interact with customers, make production decisions, establish factory footprints, and compete in their industries.

Strategy& is a global team of practical strategists committed to helping you seize essential advantage.

We do that by working alongside you to solve your toughest problems and helping you capture your greatest opportunities.

These are complex and high-stakes undertakings — often game-changing transformations. We bring 100 years of strategy consulting experience and the unrivaled industry and functional capabilities of the PwC network to the task. Whether you're charting your corporate strategy, transforming a function or business unit, or building critical capabilities, we'll help you create the value you're looking for with speed, confidence, and impact.

We are part of the PwC network of firms in 157 countries with more than 223,000 people committed to delivering quality in assurance, tax, and advisory services. Tell us what matters to you and find out more by visiting us at strategyand.pwc.com.

www.strategyand.pwc.com