

new equipment) to stream information into a data lake, where it can be analyzed for insights on cutting downtime and improving efficiency. In one plant, this approach doubled the production of defect-free units.

Simplified components. The physical complexity of products often diminishes as functionality moves from mechanical parts to software. This shift eliminates physical components, along with the production steps needed to build and assemble them. Withings, for example, has reduced its blood pressure monitor to a cuff and sensor, eliminating the display through an app that can track blood pressure and send updates directly to clinicians. Similarly, manufacturers of aircraft, automobiles, and boats are moving toward “glass cockpits,” in which a single screen displays numerous configurable gauges. As the physical complexity of products decreases, however, the quantity of sensors and software rises, introducing new parts and complexity.

Reconfigured assembly processes. Manufacturing has evolved toward standardized platforms, with customization of individual products occurring later and later in the assembly process. This approach reaps economies of scale and lowers inventory. Smart, connected products go even further. Software in the product or in the cloud can be loaded or configured well after the product leaves the factory, by a field service technician or even by the customer. New apps can be added or touchscreen keyboards set up for different languages. Product design changes can be incorporated at the last minute, even after delivery.

Continuous product operations. Until now, manufacturing has been a discrete process that ended once the product was shipped. Smart, connected products, however, cannot operate without a cloud-based technology stack. In effect, the stack is a component of the product—one the manufacturer must operate and improve throughout the product's life. In this sense, manufacturing becomes a permanent process.

LOGISTICS. The earliest roots of smart, connected products were in logistics, which involve the movement of production inputs and outputs and the delivery of products. Commercialized in the 1990s, radio frequency identification, or RFID, tags greatly enhanced the ability to track shipments. Indeed, the term “Internet of Things” was coined by a founder of MIT's Auto-ID Center, which specialized in RFID research. Today's smart,

connected products take tracking to an entirely new level. Now it can be done continuously, wherever products are, without the need for a scanner, and provides rich information on not just their current location but also their location history, their condition (their temperature, say, or exposure to stresses), and their surrounding environment.

We believe that smart, connected products will ultimately move logistics to a whole new generation. For example, the management of large, far-flung fleets of vehicles is being transformed by the ability to remotely monitor each vehicle's position and function, check its local traffic and weather conditions, and provide drivers with an optimized delivery schedule. And automated drones capable of dropping packages directly on the customer's doorstep—which are now being tested by Amazon, Google, and DHL—could revolutionize the delivery process for many products.

MARKETING AND SALES. The ability to remain connected to the product and track how it's being used shifts the focus of a company's customer relationship from selling—often a predominantly one-time transaction—to maximizing the customer's value from the product over time. This opens up important new requirements and opportunities for marketing and sales.

New ways to segment and customize. The data from smart, connected products provides a much sharper picture of product use, showing, for example, which features customers prefer or fail to use. By comparing usage patterns, companies can do much finer customer segmentation—by industry, geography, organizational unit, and even more granular attributes. Marketers can apply this deeper knowledge to tailor special offers or after-sale service packages, create features for certain segments, and develop more-sophisticated pricing strategies that better match price and value at the segment or even the individual customer level.

New customer relationships. As the focus shifts to providing continual value to the customer, the product becomes a means of delivering that value, rather than the end itself. And because a manufacturer remains connected to customers via the product, it has a new basis for direct and ongoing dialogue with them. Companies are beginning to see the product as a window into the needs and satisfaction of customers, rather than relying on customers to learn about product needs and performance.

All Traffic Solutions, for example, makes smart, connected road signs that measure traffic speed and volume. The signs allow advanced data mining of traffic patterns and help law enforcement and other customers remotely monitor and manage traffic flows. The company's relationship with customers has shifted from selling signs to selling long-term services that improve safety without the need for police intervention. The signs are simply devices through which traffic management services are customized and delivered.

New business models. Having full transparency about how customers use products helps companies develop entirely new business models. Take Rolls-Royce's pioneering “power-by-the-hour” model, in which airlines pay for the time jet engines are used in flight, rather than a fixed price plus charges for maintenance and repairs. Today many industrial companies are beginning to offer their products as services—a move that has major implications for sales and marketing. The goal of salespeople becomes customer success over time, instead of just making the sale. That involves creating “win-win” scenarios for the customer and the company.

A focus on systems, not discrete products. As products become components of larger systems, the customer value proposition broadens. Product quality and features need to be supplemented by interoperability with related products. Companies must decide where to play in this new world: Will they compete at the product level; by offering a family of closely linked products; by creating a platform that cuts across all related products; or by doing all three? Sales and marketing teams will need broader knowledge to position their offerings as components of larger smart, connected systems. Partnerships will often be necessary to fill product gaps or connect products to leading platforms. Salespeople will need to be trained to sell with those partners, and incentives will need to accommodate more-complex revenue-sharing models.

Consider SmartThings, which sells in the increasingly crowded do-it-yourself home-automation space. The company has positioned itself with both consumers and manufacturers as an easy-to-use platform for smart home devices. Its platform has a simple user interface and provides an array of standard sensors that measure such things as moisture, smoke, temperature, and motion. The sensors, which can be attached to any home object,

A NEW ERA OF LEAN

Smart, connected products will help make people, materials, energy, and plant and equipment far more productive, and the repercussions for business processes will be felt throughout the economy.

We will see a whole new era of “lean.” Data flowing to and from products will allow product use and activities across the value chain to be streamlined in countless new ways.

Waste will be cut or eliminated. Sensors in products can identify the need for service before a component fails, reducing downtime. Or they can reveal that maintenance isn't yet necessary. An oil change, for instance, will take place only after oil contamination has hit a certain threshold, rather than according to a schedule. New data analytics will lead to previously unattainable efficiency improvements.

Wasted capacity will be driven out. Because products will report on their location and use, we will be able to make the most of them. Smart, connected elevators, for example, can predict and act on user demand patterns, reducing wait times and electricity use. A building that once might have needed six elevators can provide better service with four. Product-as-a-service models will allow customers to pay only for what they actually need. With data and connectivity, the sharing of assets (think cars or bikes) will become possible or easier than ever before.

automate lighting, home security, and energy conservation. The company also makes it easy to connect smart home devices from a variety of other manufacturers to its hub and has built an extensive partner ecosystem that already encompasses more than 100 compatible products.

AFTER-SALE SERVICE. For manufacturers of long-lived products, such as industrial equipment, after-sale service can represent significant revenues and profits—partly because traditional service delivery is inherently inefficient. Technicians often must inspect a product to identify the reason for a failure and the parts needed to correct it and then make a second trip to perform the repair.

Smart, connected products improve service and efficiency and enable a fundamental shift from reactive service to preventive, proactive, and remote service:

One-stop service. Because technicians can diagnose problems remotely, they can have the parts needed for repairs in their trucks the first time they arrive at the customer site. They can also have supporting information for executing the repairs. Only one visit is necessary, and success rates rise.

Remote service. Smart, connected products make delivering service via connectivity increasingly feasible. In many cases products can be repaired by remote technicians in the same way that computers are now often fixed. The blood- and urine-analysis