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Digital manufacturing: The revolution will be virtualized

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While manufacturers are recognizing the opportunities—and threats—of digitization, few are responding in a comprehensive, coordinated way. That needs to change.

The digital revolution is now breaching the walls of manufacturing as it continues to disrupt media, finance, consumer products, healthcare, and other sectors. Indeed, the explosion in data and new computing capabilities—along with advances in other areas such as artificial intelligence, automation and robotics, additive technology, and human-machine interaction—are unleashing innovations that will change the nature of manufacturing itself. Industry and academic leaders agree that digital-manufacturing technologies will transform every link in the manufacturing value chain, from research and development, supply chain, and factory operations to marketing, sales, and service. Digital connectivity among designers, managers, workers, consumers, and physical industrial assets will unlock enormous value and change the manufacturing landscape forever.

Yet while manufacturing generates more data than any other sector of the economy, few companies are harnessing it. One oil-and-gas company, for example, discards 99 percent of its data before decision makers have a chance to use it. We believe that companies that can close this gap by tapping the data they generate (and what's publicly available) will uncover valuable insights to drive profits and growth. Consider traditional car manufacturers and Uber, which are both—at the highest level—in the business of moving people around. Car makers meet that need on the floors of factories and showrooms, using a century of manufacturing experience. Uber meets people's transportation needs not with steel, glass, rubber, and salespeople but with data, matching individual riders and vehicles via smart phones. Barely five years into its existence, it is valued at about $50 billion. Uber's data, algorithms, and enormous growth prospects have already made it more valuable than all of the physical assets, intellectual property, and brand names of some of the world's biggest car manufacturers.

It comes as no surprise, then, that manufacturers are waking up to the opportunities and threats of digitization. In the United States, the National Network for Manufacturing Innovation is organizing six major research institutes to speed new manufacturing technologies to market. While all of these institutes have a digital component, one is focused specifically on digital manufacturing.[1] Similar efforts are underway across the globe, including Germany's Industry 4.0 effort and China's Made in China 2025. One global convening organization, the Industrial Internet Consortium, was founded just 18 months ago and already has 175 members.

[1] For more information on these efforts, visit manufacturing.gov and dmdii.uilabs.org.

How leading companies are responding

The ways people and organizations use information has shifted dramatically. Data storage is cheap and flexible, and advanced analytics and artificial intelligence are giving us new abilities to draw insights from large amounts of data. Advances in virtual and augmented reality, next-level interfaces, advanced robotics, and additive manufacturing are all opening the gates to digital disruption. And in the next decade, digital manufacturing technologies will allow companies to connect physical assets by a "digital thread"—unleashing a seamless flow of data across the value chain that will link every phase of the product life cycle, from design, sourcing, testing, and production to distribution, point of sale, and use.

While this digital transformation of the $10-trillion-plus global manufacturing sector will play out over a decade or more, pioneers are moving to drive bottom-line and top-line impact in the near term. When we examine manufacturing value drivers and map them to digital levers, we find several opportunities for companies to create value by improving operational effectiveness and product innovation, as well as by unlocking new sources of revenue.[2] Some examples include the following:

- Many large manufacturers are starting to use data analytics to optimize factory operations, boosting equipment utilization and product quality while reducing energy consumption. With new supply-network management tools, factory managers have a clearer view of raw materials and manufactured parts flowing through a manufacturing network, which can help them schedule factory operations and product deliveries to cut costs and improve efficiency. Smart, connected products are sending customer experience data to product managers to help them anticipate demand and maintenance needs and design better products. Players in a wide range of industries are deploying digital technologies in different ways to drive value.

  A major metal plant, for example, has used digital tools to make step-change improvements in throughput. Real-time performance visualization in operator pulpits combined with daily problem solving led to a 50 percent increase in production rate in one of its lines. By mining data, engineers are gaining new insights into the failure characteristics of major equipment modes and making continuous improvements in reliability. The company expects to use condition monitoring and predictive maintenance, in conjunction with process controls and automated material tracking made possible with big data analysis, to drive a 30 percent increase in production without a substantial increase in operational costs.

- Pharmaceutical manufacturers are using their deeper understanding of end-to-end processes to develop continuous manufacturing suites with footprints less than half the size of conventional factories. Some have even developed portable factories that can be built in 40-foot trailers. They are also using the digital thread to improve quality control: continuously monitoring conditions within mixing vessels, tablet presses, lyophilizers, and other critical equipment. A few companies are now relying on infrared technology to detect counterfeit medicines and contaminants without the conventional destructive tests—at production-line speeds. As the industry brings these advances to the market, leaders will transform the Three Sigma industry performance to peer industry performance of Six Sigma or greater.

[2] Our McKinsey Digital Compass identifies eight typical value drivers in a manufacturing operation—asset utilization, labor efficiency, inventory, quality, supply/demand match, time to market, service and aftersales, and resource and process effectiveness—and maps them to important digital-manufacturing levers. For more, see Cornelius Baur and Dominik Wee, "Manufacturing's next act," June 2015, mckinsey.com.

- Leading consumer-packaged-goods companies are using digital tools to improve distribution and build bonds with consumers. Global fashion retailer Zara is already renowned for developing and shipping new products within two weeks. It is now using digital tools to respond even faster to consumer preferences and reduce supply-chain costs, attaching reusable radio-frequency identification (RFID) tags to every item of clothing in more than 700 of its 2,000-plus stores. Ten staff members can now update a store's inventory in a couple of hours—work that used to take 40 employees more than five hours—by waving small handheld computers at racks of clothing. The retailer expects to complete the shift to wireless inventory in 2016. We believe the falling costs of RFID hardware and associated software are likely to aid this transition.

- The aerospace-and-defense industry is using digital tools to integrate an enormously complex supply network. A modern jet turbine engine has hundreds of individual parts, for example, some of which the engine manufacturer makes in-house and others it sources from a network of dozens of vendors. The complexity of sourcing can multiply quickly, since making one design modification can impact the manufacturing of many other components. Cloud computing–based tools allow suppliers to collaborate faster and more efficiently: an engine maker can share three-dimensional models of component design within its network, and each supplier in turn can share information about price, delivery, and quality. This type of information sharing and transparency reduces the labor required to manage design changes, reduces risk for the engine maker and suppliers, and speeds changes across the supply network. Boeing developed its two most recent airframes, for the 777 and 787, using all-virtual design, reducing time to market by more than 50 percent.

Questions the C-suite should ask

The digital revolution is only beginning to take shape. But we do know that leaders in digital manufacturing, including some smaller players, are already gaining significant competitive advantage by harnessing the capabilities of workers, designers, managers, and suppliers, speeding the pace of innovation, lowering the costs of production and maintenance, and increasing the impact of marketing. We believe that every player should be asking five questions:

1. How will digital disrupt my industry in the next five to ten years, and what new ecosystems will emerge?

2. Where is the value for my company, and how can we maximize it?

3. How close is the revolution to our factory doors, and where should I make investments in infrastructure, cybersecurity, and partnerships?

4. What new capabilities, skills, and mind-sets will we need in our organization? How will we identify, recruit, and retain the right new talent?

5. What should we pilot now to start capturing this value?

No company has harnessed every possible digital advance, but many have begun to make real progress. One thing seems certain: in marketplaces where profit margins are thin and consumers demand ever more sophisticated products and better service, the digital thread will lead some companies to great success while slow-moving competitors fall further behind.

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