Mastering Disruptive Change in Manufacturing

New Manufacturing Technologies

With manufacturing technology heading in dramatically new directions, keeping pace with the latest developments is more important than ever. Executives need to keep their eyes open and be prepared for a very different world from today.
Stories about new manufacturing technologies and their possible applications are dominating the news. Enabled by intelligent manufacturing systems, technologies such as collaborative robots or 3D printing could potentially transform—or even replace—conventional manufacturing operations and lead to “fab labs” (also known as distributed manufacturing facilities) popping up everywhere. As usual with new developments of this magnitude, skeptics will be eager to point out that there’s much more hype than real opportunity, but nobody disputes that these new technologies are worth paying attention to.

“It’s Inevitable, My Dear Watson”

When automated production and the robots that made it possible were first introduced, they were initially used as a step up from power tools. Robots were able to work longer hours, didn’t need to rest, strictly followed instructions, and weren’t prone to human error. Yet even today, after several decades, automated production still remains a step short of the promise of cognitive robots, where learning machines the likes of IBM’s Watson collaborate with or even take over completely for manufacturing laborers. The main reason is that safety cages are needed to separate capital-intensive robots from human workers, since robots simply execute orders and cannot detect situations that could endanger their human coworkers. Today, automation experts continue to strive to get robots “out of the cage” and bring a “lights-out” manufacturing environment one step closer.

If these efforts succeed, future human-robot collaborations will combine human intelligence and problem-solving agility with the durability, reliability, and precision of robots, presumably at much lower cost and with better quality. As programming becomes quicker and easier (for example, via motion or voice control) or as robots are able to “learn,” the traditional factory model may be profoundly transformed. Some manufacturing environments are already headed in this direction: car manufacturers such as BMW and Daimler are about to introduce collaborative robots on a large scale to replace the final assembly activities currently completed by human operators (see sidebar: Let’s Work Together).

In the long run, as manufacturing reaches a completely new level of automation, the balance will further shift toward the complete elimination of the human factor (see sidebar: Lights Out! on page 2). Although the impact on the plant floor will be profound, the main potential lies in the production management office. Whereas today a lot of manual effort and time is spent on planning, managing, and executing nonproductive tasks such as scheduling, changeovers, maintenance, and loading of parts, in the future large-scale production environments may manage themselves via digital models, simulations, robots, sensors, condition-based systems, and artificial intelligence. Some of the building blocks required to get to this point are already well-established and in industrial use, while others—for example, predictive

Let’s Work Together

BMW recently introduced four still relatively slow-moving, collaborative robots at their U.S. plant in Spartanburg, South Carolina. Those robots work hand in hand with a worker to water-seal and insulate doors. While the worker holds the parts in their correct position, the robot applies glue and insulation material in such a way that the worker doesn’t have to make any strained movements and remains safe from potential physical harm. BMW plans to roll out similar human-robot collaboration stations—with the capability to perform additional tasks—in other sites across the globe.
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maintenance—are still in research. When these technologies are mature, the economics of manufacturing operations will be drastically improved.

Even though more research will be required before most plants can be operated by integrated intelligent manufacturing systems, one thing is already certain: with the increasing importance of information technology and self-managed systems, the need for blue-collar workers will decrease. Meanwhile, white-collar workers with deep skills in areas such as modeling and simulation will increasingly be sought after to set up and maintain these systems.

3D Printing Adds to Manufacturing

Although a fully automated “lights-out” plant is still a few years away, other new technologies are already disrupting the manufacturing landscape. Additive manufacturing, for instance, has the potential to turn today’s supply chains and manufacturing plants upside down. 3D printing, perhaps the most promising of the additive manufacturing technologies, allows the production of solid three-dimensional objects by layering materials using digital technology. The global market for this technology is currently growing at an annual rate of 20 percent, and we estimate that it will reach between $25 billion and $50 billion by 2025.

3D printing has a lot going for it, as it helps meet three of modern production’s most pressing objectives: customer proximity, product localization, and complexity management. It fulfills the needs for individual customization at little or no additional cost (at least when compared to traditional manufacturing processes). “Series of one” will thus become the new normal, finally ushering in the era of mass customization. Today, for some applications, 3D printing has already surpassed traditional manufacturing. In medical devices, especially in applications where small lot sizes and complex, individualized products (such as hip stems and dental crowns) are the rule, 3D printing offers unit cost advantages that conventional manufacturing technologies simply cannot match. In a more experimental application, the technology has also been used to “print” part of a lung that was successfully implanted into a newborn child. Research is also ongoing into manufacturing products such as heart valves or even a complete heart. For example, the Free University of Berlin is focusing on producing heart valve implants that start out as 3D-printed parts. Once introduced inside the human body, the printed parts would gradually disintegrate as they are encapsulated by the body’s own living tissue. And at the University of Iowa researchers are going one step further: they are bringing two technologies together as they research 3D printing of organs made out of “bio-ink” based on living organisms. As the technology keeps progressing, 3D printing may even surpass traditional manufacturing.
for large-series applications, provided that personalized 3D-printed products can be offered at similar prices to traditional mass-manufactured products.

Given that economies of scale are not a factor in 3D printing and entry barriers are low, the democratization of manufacturing may be possible. Growing numbers of consumers are using marketplaces such as Shapeways (see sidebar: Scaling Up, Shapeways-Style) and Ponoko to make, share, buy, and sell their own 3D products. Although many of these products arguably are just novelties with very little commercial viability, the fact that it’s possible to make them at all indicates we may be at the beginning of a new era.

Manufacturing executives should seek input from expert networks that keep their eye on the forefront of technology.

Not only new entrants see the disruptive potential of additive manufacturing technologies; traditional manufacturers also realize there’s a shift going on. General Electric (GE) Global Technology Director Christine Furstoss was quoted saying that up to half of the parts in GE’s energy turbines and aircraft engines could be 3D printed by 2022.¹ Currently, GE uses 3D printing for certain products such as engine parts and ultrasound transducers to reduce weight, improve design flexibility, and increase efficiency. The company has even set up its own lab that focuses on additive manufacturing research and acquired players, such as Morris Technologies, that specialize in additive manufacturing. The open challenge for mission-critical parts is process control to ensure consistent quality. GE also launched the crowdsourcing manufacturing platform vehicleforge.mil together with the Massachusetts Institute of Technology (MIT) and the U.S. Defense Advanced Research Projects Agency (DARPA) to create highly complex military vehicles. In April 2013, GE also announced a new partnership with Quirky, a product development company that develops globally crowdsourced products, from iPod cases to 3D printing vending machines.

Local Motors is another successful example of open-source 3D printing seeking to disrupt established industries. The Rally Fighter from Local Motors is the first car built by an open community using, at least for part of its design, additive manufacturing technologies. These

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¹ Source: Paul Davidson, “More Goods Come From 3-D Printing,” USA Today, 10 July 2012

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### Scaling Up, Shapeways-Style

Shapeways, founded in 2007 in the Netherlands as a spin-off from Philips Electronics, has created a marketplace where users can upload their design, choose materials, get instant pricing, and order their own products to be manufactured by 3D printing machines. Then, Shapeways produces and ships the individualized products to the customer.

In October 2012, after having already sold 1 million printed products worldwide, the company took the next step toward a decentralized production network and opened a Factory of the Future on Long Island, New York, with the capacity to produce 3 to 5 million objects per year with up to 50 3D printers.
socially developed products show a trend toward greater consumer involvement in the manufacturing process. Though they offer greater design and manufacturing flexibility, shorter time-to-market, and less wasted material as some interesting benefits, additive manufacturing and open-source manufacturing also hold some risks. For example, the technology and the open-design environment make it challenging to protect intellectual property (IP). Digitization, global connectedness, and the distributed nature of 3D printers make it easier to replicate parts in areas where IP is unprotected, opening up opportunities for less scrupulous competitors. There is also the risk that suppliers of certain materials may exercise market dominance to drive costs up.

Be Prepared

With manufacturing technology heading in dramatically new directions, keeping pace with the latest developments is more important than ever. To be successful in the future, manufacturing executives will want to keep the following advice at the top of their minds:

- Continue to actively and systematically scan the new technology frontier, taking advantage of, for example, supplier and customer know-how and industry panels. Cooperation with research institutes should also be on the radar.

- Develop a clear road map to test and adopt the most promising technologies, so that your organization is quick to identify which new technological direction to take and ready to move in that direction as soon as the opportunity or the need arises.

- Assess your own operations and prepare them to quickly adopt the new technological direction. This requires a rigorous self-assessment of factories’ capabilities to take advantage of the technologies.

Executives need to be prepared for a manufacturing world that’s significantly different from today and seek input from expert networks that keep their eye on the forefront of technology. Understanding the business opportunities, and the risks, associated with these and other new technologies will be a vital part in developing a global manufacturing strategy that’s fit for the quickly evolving times we live in.

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