



## The Future of Manufacturing

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The future of manufacturing is digital—through sensors, software, robots and cobots, and connectivity. In the last installment of our Convergence series, which examines five growth themes that are shaping the future of investing, Hugo speaks with William Blair Global Research Associate Monika Budyn and Global Research Analyst Andy Siepker, CFA, about the “rise of the machines.”

Comments are edited excerpts from our podcast, which you can listen to full below.

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**Andy, I hear you talk about the future of manufacturing almost every day. What do you mean by that?**

**Andy:** It’s all about automation—not just physical automation (the production and movement of goods in a factory) but also the digitalization of designs of workflows.

Think of how the modern automobile comes to market. It’s designed virtually, and performance is simulated in a virtual environment. They even design and test production facilities virtually before putting in place physical processes.

The result is a much better product. We've seen dramatic improvements in the quality of vehicles over our lifetime. For example, vehicle fatalities on a miles-driven basis have improved by more than 35% over the past 20 years.

**Throughout my career in investing, the future has always been about automation. So why are we diving so deeply into this now?**

**Andy:** A confluence of factors is leading to automation becoming more important. First, we need the productivity gains: For several decades we clipped along at about 3% to 4% productivity gains annually, but over the past decade this has ground to a halt. Second, there's been more emphasis in society on doing things efficiently, limiting emissions and reducing waste. Third, over the next decade we're going to be short 2 million manufacturing jobs (due to the industry growing and the workforce aging), so we need to address labor shortages.

Also, a lot of the automation solutions coming to market are delivering very clear benefits to customers. Predictive maintenance offers particular promise. The cost of downtime for a factory is very high, in some cases millions of dollars per hour. So more uptime provided by predictive maintenance delivers value for customers.

**You often hear the term "Industry 4.0" used to describe this increase in automation. Monika, do you agree with that? Is this really a step change, a meaningful evolution in the way stuff is made? Or is that too dramatic a statement?**

**Monika:** I think Industry 4.0 absolutely has the potential to unlock a step change in productivity. Many are calling this the fourth industrial revolution. We're really seeing adoption pick up, with manufacturing software investment growing three to four times faster than capacity.

Unlike physical automation, which is already quite mature in terms of technology, digital automation maturity varies quite a bit by industry. Adoption rates are relatively high in autos, but still quite low in heavy industry, such as oil and gas and construction.

The key to Industry 4.0 is bridging the gap between the physical and digital worlds, and that's done through the use of digital twins.

In its simplest form, a digital twin is a virtual model of a physical aspect. Digital twins can be used throughout the lifecycle of an asset, from design all the way through post-production monitoring. Sensors capture data from an asset and feed it back into the virtual world. Optimization can then be simulated and fed back into the physical world, creating a continuous feedback loop.

An example of this is a sensor that picks up a deterioration of a part in an assembly plant. That information flows into the digital twin, which can assess the severity of the problem. Maintenance can be deployed at a convenient time without disrupting production.

But digital twins can be applied on a much larger scale to entire production facilities. All of this results in greater efficiency, shorter production cycles, improved quality, and overall better asset lifecycle management.

**What does this all mean for business models? What does the successful industrial company of the future look like versus the past?**

**Monika:** We think there's definitely an opportunity for new business models, such as services that help companies exploit all of the data that they're capturing—data analytics, customization, and enhanced aftermarket offerings.

Aftermarket offerings, which are often a significant component of profit, are particularly important. An extreme example is a razorblade model like we see with airplane engines, where as much as 75% of the lifetime value of an asset can come from aftermarket. Industry 4.0 enhances the value proposition the service provider can offer, such as predictive maintenance, remote monitoring, or guaranteed uptime.

These new types of service models can be especially appealing in industries where downtime can be extremely costly. Think of the production output lost in a manufacturing plant where a production line has to stop due to a part failure, or even the disruption caused by something as simple as an elevator failure in a commercial building during rush hour.

These new models can help address these challenges and minimize the impact to operation, and we think this creates an opportunity for expanded and customized aftermarket offerings, depending on customers' needs.

However, this is not an unmitigated positive for the service providers, because more data and connectivity can lead to more efficiency, and eventually to a deflationary market.

**I think what I'm hearing, and tell me if you disagree, is that switching costs are going to rise. Customers are going to be more tightly bound to manufacturers. Do you agree with that?**

**Monika:** Absolutely. If the service operator can provide 24/7 monitoring for the customer, that kind of ensures the relationship remains for the duration of the lifecycle of the asset and not just for the point of sale.

**Andy:** It's an opportunity and a threat. The best companies will harness this opportunity and the use of data to deliver greater value for the customer, new and better solutions. There will be some companies, though, that don't utilize this opportunity to get closer to the customer, and those companies are at risk.

**If software is so important, does that mean that manufacturing hardware is commoditized?**

**Andy:** I think there's a big misconception—probably formed by our consumer experience with technology, where disruptions happen fast and things become commoditized quickly.

Hardware used in industrial applications is highly sophisticated and highly specialized, with a lot of intellectual property (IP), not only in the product itself but in the production processes. These products are very hard to reverse engineer, which is why industrial automation companies that are hardware-centric tend to have strong profitability. In a manufacturing setting, you also have a little risk taking. You have proven processes that work, and if a new offering comes along, there's some hesitancy to try it.

So, hardware being commoditized—we're not seeing that. Though, there is some variance across products. The more IP in the product, the less the risk of commoditization. But I think it's much different than consumer-facing goods.

**Everybody likes automation. But how do you think about winners and losers in automation?**

**Andy:** The good news is there are likely going to be more winners than losers because these are big and growing markets. The automation companies that have grown up on the factory floor are adding more software to their hardware to create more solutions and deliver more value.

Alternately, technology companies recognize that new solutions being driven by software are coming primarily from the enterprise level, and are partnering with industrial automation companies to bring fuller, more robust solutions to customers. I think it's going to be a happy future where a lot of these companies coexist because the opportunities are so big.

**Where should we look for automation growth? And it just occurred to me that none of us has mentioned robots.**

**Andy:** Robots and airplanes are some of our favorite topics. And you're absolutely right, robotics is a very significant area growth. You can take it in a lot of different directions.

The classic manufacturing setting—for example, the assembly of a car—is further along the maturity curve in terms of robotics penetration.

Probably more exciting on the robotics front is moving into new applications. Think about warehouses. Picking goods in a fulfillment facility has been very labor intensive; until recently, you couldn't use robotics. But now with Vision (which lets you see and react to your environment), you can pick and pack with automation.

If you look further out, a massive opportunity we're really just scratching the surface on is robotics in the service industry. There are tens of millions of service jobs in the United States alone. These are often not the most exciting jobs. Robotics—particularly what we call collaborative robots, which are robots humans can work next to—have a lot of dexterity and can automate some of these service jobs. This should be a big growth driver for robotics for many decades to come.

**It's time for my favorite question of our growth themes series, which is the moonshot question. I'm also interested in the effects of what were moonshots but are now actual things. So all of the things we just talked about, what do they mean for people? Are all of us going to see the benefits of this in our everyday lives?**

**Monika:** We actually see a lot of exciting opportunities in the consumer space. Not only will product quality improve, but a lot of these applications that we've talked about already are trickling down into consumer products. Take the heart rate monitor as an example. It's essentially the first step towards a human digital twin.

Next, Andy's already talked about the service industry opportunity a bit. But it can also be expanded to use-cases in the home. Think of a robot that can do the dishes or that can clean the bathroom.

Another exciting area is dark factories, where you essentially turn the lights off and let robots run the factory. On a

small scale, this is already being done. But an extreme example—and potentially maybe a scary one—is that you could have robots building robots with little or no human intervention.

The last moonshot I'll put out there is autonomous vehicles. This could really be a game changer. The technology for wide customer adoption is probably still years away, but we see a lot of potential for robo-taxis being widely deployed within our lifetime.

**Andy:** I agree. Automation in manufacturing is going to lead to better outcomes in our daily lives. As Monika mentioned, in a domestic setting, you can dream of a scenario where the housework's done by a robot. Your car drives itself, so time we waste in traffic is given back to us. And we all enjoy the benefits of safer, higher-quality products that are made with a lighter environmental impact.

On the professional side, robotics (and automation more broadly) leads to a discussion of job displacement. Yes, there will be job displacement. But there are a lot of shortages in the affected industries. The jobs that are being automated are also typically dull, dirty, and sometimes even dangerous. So we're going to be able to redeploy workers into knowledge jobs that are more enjoyable and should, as a society, lead to greater innovations. This is very important for growth for all of us. I think it's going to be truly exciting to watch how it unfolds.

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