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# Manufacturing in the 21st Century

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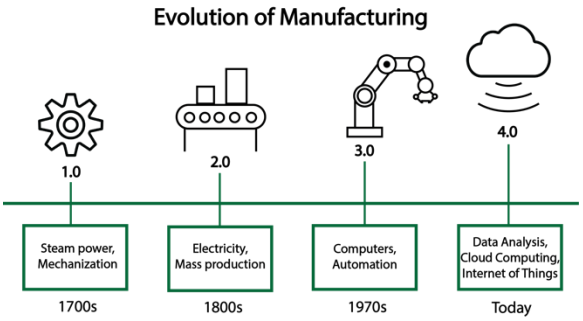
# MANUFACTURING IN THE 21ST CENTURY

## INTRODUCTION

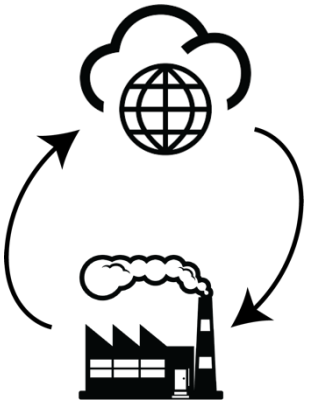
With the manufacturing sector driving nearly 50% of Northeast Ohio's economy, understanding advancements in this industry is critical to keeping our region competitive. In this brief we examine dynamics of industry stages of advancement and make recommendations for what our region can do to integrate industry improvement.

The Industrial Revolution of the late 1700s, now referred by some as Industry 1.0, introduced steam power and machine manufacturing, while the second industrial revolution of the 1800's, known as Industry 2.0, brought advancements in electricity and mass production. The arrival of computers around the 1970s kicked off Industry 3.0, thus setting the stage for more rapid advances. In fact, after nearly a century or more separated 1.0 and 2.0, and 2.0 and 3.0, less than 50 years passed before we were faced with Industry 4.0. This new shift in manufacturing technologies largely revolves around connectivity, digitalization, processing information, improving production, deploying the workforce and other resources, and supply-chain processes. While we continue to grapple with the effects of manufacturing industry 4.0 deployment, there is already talk of Industry 5.0 based on the interaction of humans and robots in the future.




Advancements from 1.0 to 2.0 to 3.0 did not simply improve how we produced goods. These advancements also allowed fundamental changes to society. To understand Industry 4.0, defined by one German executive as "production networking and the digitized connectivity between suppliers and customers across the complete value chain",[1] we need to understand the modern consumer. According to Deloitte, products are becoming "less objects of value in their own right and more the means for accessing information and experiences."[2] Key to this new experience is the immediacy of customers' demands. To meet this expectation, manufacturers must have immediate access to information themselves.

## WHAT IS 4.0?



Manufacturing 4.0, and its embedded immediacy, is primarily driven by data and the knowledge discerned from the data analyses. Not only can we program computers to complete production tasks, but these computers are now connected to the internet, allowing for the collection and dissemination of an abundance of real-time data on everything from production, supply chain, logistics, and even customer satisfaction. The information gleaned from this data can reveal bottlenecks in production, an inventory reduction, or point to the end-users' problems. These computers are also connected to the cloud, a network of interconnected servers that stores and allows users to access information from any internet-connected device. The cloud enables companies an efficient means to store an abundance of data accessible by anyone who needs it in seconds. This feature is essential for worldwide suppliers who may have employees around the globe relying on the same information.

[1] Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, *132*, 2–17.

[2] Deloitte Center for the Edge. (2015). *The Future of Manufacturing*. Deloitte University Press.

It is not just connected computers, but rather any machine on the shop floor is now capable of being programmed to store and share information via the internet or cloud. This connectivity beyond computers is often referred to as the Industrial Internet of Things, or IIoT.

The Internet of Things is a concept developed in recent years to describe a fully digitized and interconnected ecosystem. The way most people interface with these systems is within the home, with cloud-connected, remotely-controlled thermostats, refrigerators, and even cars. As in the household, applying this concept to the industry means identifying what processes can be done remotely and virtually. Essentially, it is a matter of looking within the office and at the production floor to find tasks that can be done more efficiently with an automated, digital process. But while a large part of surviving and thriving in the world of Industry 4.0 will be a firm's ability to make these identifications, that firm also must have the means to adjust to a digital process.

For the supply chain, Industry 4.0 includes a savvier customer base and integrated products, which have shifted from being commodities to becoming platforms for services. Simple products, such as those household items, now come with phone apps and monthly subscription plans, providing more data and revenue for suppliers.

## NEO FALLING BEHIND

With the manufacturing sector driving nearly 50% of Northeast Ohio's economy,[3] understanding Industry 4.0 and its potential to reshape the industry is vital. As of now, though, our regional economy appears to be falling behind. Industry 4.0 is considered "low priority" for most Northeast Ohio manufacturers, 98% of whom are small and medium-sized companies. These companies are more likely to struggle to find the resources for implementing these technologies. Larger companies are more likely to have employees dedicated explicitly to strategizing and implementing new processes and technologies, while smaller organizations often must take leaders and top producers away from day-to-day operations, resulting in a reduction of capacity and productivity. As with previous industrial innovations, the larger players in the sector will initialize the adoption of Industry 4.0 due to their ability to put large amounts of capital into testing and adoption.


Small and medium-sized firms tend to adopt technologies later once the larger companies begin to demonstrate real advantages and financial returns with these technologies. This phenomenon makes it difficult for most of NEO's manufacturing firms to be at the forefront of sector-wide advancement.[4] Additionally, the time lag between identifying a solution, testing, implementing, and realizing a return on the investment can take years. The companies' leadership may see a technology investment with a long-term return as riskier than other areas where they could reinvest their profits.[5]

This delayed engagement is still true even for Industry 3.0 technologies. While many small- and medium-sized

[3] Manufacturing Advocacy and Growth Network. (2021). *MAKE IT BETTER: A Blueprint for Manufacturing in Northeast Ohio.*

[4] Karp, E. (2021, May 13). *Manufacturing Is Booming Again. Here's How To Invest Into The Boom*. Forbes.

[5] Karp, E. (2021, April 7). *Here's How The Biden Administration Can Revive U.S. Manufacturing*. Forbes.

businesses have invested in people and equipment, they have not proportionally invested in the information side of their business. This is evident in the number of firms that do not yet have digital ERP, MES, or WMS systems and others that are working with software that is no longer supported. These technologies are basic foundational enablers for the data required by 4.0 technologies.


There are, however, gains to be realized from investing in technology. While the investment may be expensive, improving efficiency can increase the company's competitiveness with international suppliers, many of whom have a built-in advantage due to lower labor costs, especially in places like Mexico, China, and other Asian countries. For example, according to a recent survey of Northeast Ohio manufacturers, of companies that increased revenues by at least 10%, more than one third did not have to expand their workforce. Higher productivity means higher revenue.[6]

## IMPLEMENTING 4.0

For manufacturers in established markets, diversifying revenue streams from "value adds" can increase a company's bottom line as well. As an example, some manufacturers are building "digital twins," or a computerized model of a machine. This model, known as "as-a-service," provides suppliers an opportunity to stay connected to the customer after the sale by collecting and providing their customer product performance data in real-time. This provides a window into the production process to identify bottlenecks and other inefficiencies that may be slowing production. Continuous monitoring also allows the supplier to predict or identify pending machine failures before they halt production. No loss of revenue for the customer and potential maintenance revenue for the supplier means both parties come out ahead.[7]

Manufactured goods that were once a product in themselves can also now become platforms for an "actual" product. For example, the popular fitness company, Peloton, creates exercise bikes that have varying subscription levels for access to prerecorded and live classes, the ability to analyze post-workout data, view leaderboards, and become part of the Peloton ecosystem. What was once a one-time product purchase, the exercise bike itself, is now the purchase of the product plus a monthly recurring cost for a host of accompanying product-related experiences. They can then use the data gathered from users to decide which classes are more popular, which customers might need a notification sent to their phone to remind them to use the product, and even what products are used most. This data gathering and analysis implementation lead to better, more desirable end-products, and for manufacturers, better knowledge of what materials to produce.

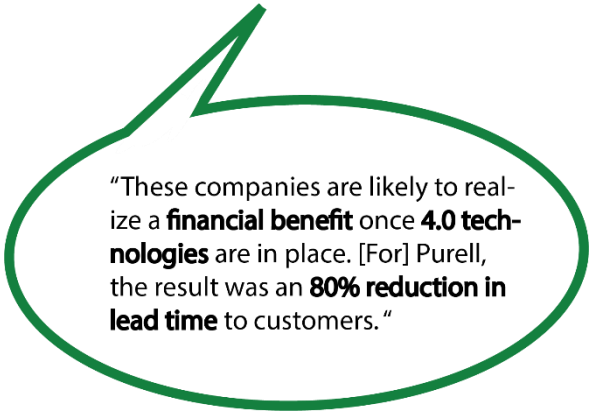
## ADOPTION PROCESS

To understand how we can drive greater adoption of Industry 4.0 in our regional economy and provide local manufacturers the increased opportunity that potentially comes with it, we can look at not only what led to the adoption of 4.0 technologies elsewhere, but what led to the adoption of 3.0 technologies prior to

[6] Manufacturing Advocacy and Growth Network. (2021). *MAKE IT BETTER: A Blueprint for Manufacturing in Northeast Ohio.*

[7] Arcot, R. V. (2019). *digital twin Helps Push Manufacturing-Performance Boundaries*. International Society of Automation.

that. If we do so, we will notice trends that span both 3.0 and 4.0 adoption. Value creation is a key motivator for those who choose to adopt 4.0 technologies. Value can be created in any number of ways, such as increasing productivity or reducing energy consumption. Creating this value internally then allows the manufacturer to offer additional value to its customers through faster delivery (increased productivity) and lower costs (reduced energy consumption in production).[8] These companies are likely to realize a financial benefit once 4.0 technologies are in place. More satisfied customers are, of course, a nice bonus. For instance, Gojo, headquartered in northeast Ohio, invested in digitizing their label printing and quality checks for their hand sanitizer, Purell. The result was an 80% reduction in lead time to customers.[9]




Another reason companies adopt advanced technologies is the belief that doing so will give them a competitive advantage in the marketplace.[10] With societal shifts towards instant gratification and customization, the ability to provide a customer with something a competitor cannot, whether through additive manufacturing and the ability to 3D print a custom output or through highly complex and precise processes that must meet specific tolerances, can be the difference in gaining the business or losing it to someone else. Just ask Youngstown, OH's M7 Technologies. As an early adopter of precision digital measurement machines for the steel, iron, and aluminum industries, the pinpoint accuracy they were able to provide on the parts they manufactured extended the life of their product, thus providing their customers with something nobody else could […] a longer product lifecycle.

As a last resort, and what may happen in Northeast Ohio if voluntary adoption levels do not increase, some companies adopt advanced technologies because they have no choice. Larger companies are more likely to adopt new processes, therefore putting pressure on smaller and medium-sized companies in their supply chain to adapt or suffer the consequences.

While the consequences of not adopting advanced technologies may not be immediate or catastrophic (total business loss), the erosion of customer satisfaction and longer-term competitiveness cannot be overlooked. Basic expectations of customer service and satisfaction for businesses of all sizes are increasing. Being open to change and adopting of new technologies allows for more efficient planning, faster response time, self-service for customer inquiries, higher employee engagement and retention, and improved business performance. Conversely, companies that do not adapt will eventually lose competitive advantage, customers, and employees.

Compatibility, or whether the concept of change itself fits into the company's culture, also plays a key role in determining how successful a company may be in adopting advanced technologies. If leadership is rigid and hesitant to change, adoption of forward-thinking

[8] Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, *132*, 2–17.

[9] Manufacturing Advocacy and Growth Network. (2021). *MAKE IT BETTER: A Blueprint for Manufacturing in Northeast Ohio.*

[10] Millen, R., & Sohal, A. S. (1998). Planning processes for advanced manufacturing technology by large American manufacturers. *Technovation*, *18*(12), 741–750.

processes may be more difficult compared to companies with a history of being open to change.[11]

## POLICY RECOMMENDATIONS

Even after companies decide to adopt advanced technologies, there are a few key considerations they must make during the process. Small and medium-sized businesses must be strategic in what they choose to do. These companies are, of course, smaller than large, multi-national conglomerates; therefore, there is likely less disposable income to spend on implementation and training. Even obtaining the right information to help decide what, if anything, to adopt can be a barrier to adoption itself. Assuming a company can afford to invest, coordinating implementation with customers, suppliers, and others in the value chain can reduce the likelihood of problems resulting from incompatibility, confusion, or misunderstandings of the changes and expectations. Due to their inability to invest directly in the push towards Industry 4.0, smaller and medium-size firms can look to the early attempts at Industry 4.0 implementation by larger firms as a testing phase, and identify which processes may be worth exploring further, saving them money, yet allowing them to keep pace with sector leaders.

With productivity and GDP in the sector rising, small and medium-sized firms may not be hard-pressed to adopt Industry 4.0 advancements immediately, but the changes will eventually become necessary. It's hard to imagine a world where a factory without any computers can compete in the same sector with modern facilities. As we head towards the world of Industry 5.0, it will be hard for firms that are still at a 3.0 level to compete. As humans and robots begin to work together with increased efficiency and accuracy, firms that have failed to automate relatively simple office tasks will not be able to gain or maintain a competitive advantage.

The ongoing labor shortage introduces a dilemma into the adoption process; firms are struggling to hire skilled workers that understand and can implement highly technical systems, but this struggle showcases the need to implement those very systems. To overcome this dilemma, larger firms can increase wages and outsource R&D relatively easily. Smaller and medium-sized firms, however, will have to let large firms serve as quasi-testing grounds and do the same type of outsourcing and/or seek other avenues to gain the capital necessary to invest in advancements. This will further exacerbate the lag time with which these smaller and medium-sized firms adopt industry 4.0 related technologies.

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[11] Oettmeier, K., & Hofmann, E. (2016). Additive manufacturing technology adoption: an empirical analysis of general and supply chain-related determinants. *Journal of Business Economics*, *87*(1), 97–124.