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Manufacturing in the 21st Century

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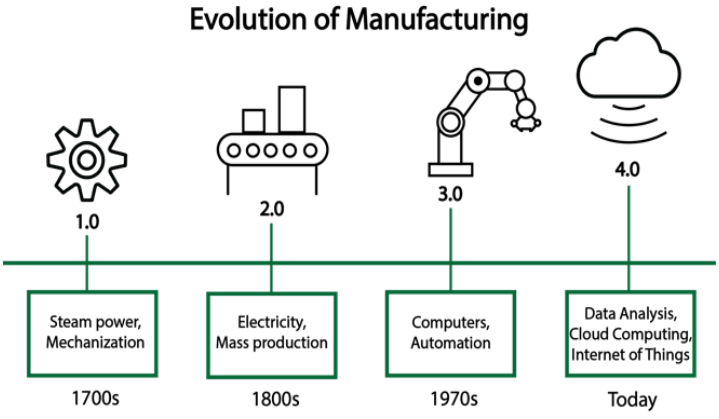
MANUFACTURING IN THE 21ST CENTURY

INTRODUCTION

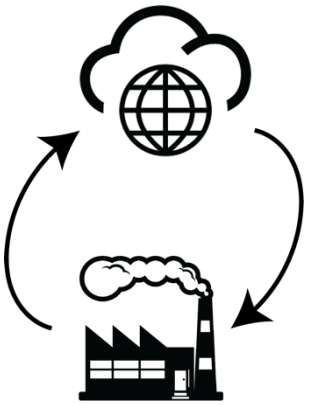
The manufacturing sector drives nearly 50% of Northeast Ohio's economy, so understanding advancements in this industry is critical to keeping our region competitive. In this brief, we examine the dynamics of advancing industry stages and make recommendations for improving regional industry integration.

The Industrial Revolution of the late 1700s, commonly referred to 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 progress. Although over a century separated 1.0 from 2.0, and 2.0 from 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, supply-chain processes, and deploying the workforce and other resources. While we continue to grapple with the effects of manufacturing industry 4.0 deployment, there is already talk of Industry 5.0, which will include the interaction between humans and robots.



Advancements from 1.0 to 3.0 did more than improve how we produce goods. This growth also created fundamental changes to society. Meanwhile, 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] The key to accessing new experiences is meeting the immediacy of customers' demands, which requires manufacturers to have immediate access to information as well.

WHAT IS 4.0?



Manufacturing 4.0, and its embedded immediacy, is primarily driven by data and the knowledge discerned from data analyses. In addition to programming computers to complete production tasks, these computers are now connected to the Internet, allowing for the collection and dissemination of an abundance of real-time data on production, supply chains, logistics, and customer satisfaction. The information gleaned from this data can reveal bottlenecks in production, an inventory reduction, or point to 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 provides companies with an efficient means to store an abundance of data accessible in seconds. This feature is essential for worldwide suppliers who may

[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.

have employees around the globe dependent on accessing the same information.

Beyond connecting computers, 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. Most people interface with these systems in the home through cloud-connected devices, remote-controlled thermostats, smart refrigerators, and even wifi-capable 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 in the office and at the production floor to discover which tasks can increase efficiency through an automated, digital process. However, while a large part of surviving and thriving in the world of Industry 4.0 will be determined by a firm's ability to make these identifications, that firm also must have the means to adjust to a digital process.

In considering the supply chain, we must remember that Industry 4.0 includes a savvier customer base and integrated products, which have shifted from mere commodities to also being platforms for services. Simple products, such as those aforementioned household items, now come with 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. At the moment, our regional economy appears to be falling behind because Industry 4.0 is considered "low priority" for most Northeast Ohio manufacturers, 98% of which are small- and medium-sized companies. These companies are more likely to struggle with implementing newer technologies due to a lack of resources. Moreover, larger companies likely have employees explicitly dedicated to strategizing and implementing new processes and technologies, while smaller organizations are often forced to take leaders and top producers away from day-to-day operations, resulting in a reduction of capacity and productivity. As in previous industrial innovations, the larger players in the sector will initialize Industry 4.0's implementation because they can afford to dedicate large amounts of capital into testing and adoption.

Small- and medium-sized firms tend to adopt technologies later once larger companies experience advantages and financial returns from 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 and implementing it, and then 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]

[3] Manufacturing Advocacy and Growth Network. (2021). "A blueprint for manufacturing in Northeast Ohio." *Make it Better.*

[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*.

This delayed engagement is still true for Industry 3.0 technologies. While many small- and medium-sized 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 other companies still 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 initial investment may be expensive, improving efficiency can increase the company's competitiveness with international suppliers, which tend to 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 due to increased efficiency. Ultimately, higher productivity leads to 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 customers post-sale by collecting information and providing them with 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. Positive consumer experience combined with potential maintenance revenue for the supplier means both parties come out ahead.[7]

Also, manufactured goods that were once a product in themselves can now become platforms for multiple, subscription-based products. For example, the popular fitness company, Peloton, creates exercise bikes that charge an additional monthly subscription to, place on the leaderboard, access live and on-demand classes, follow and engage with other members, and track and analyze post-workout data; in other words, 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. Peloton then uses the data gathered from users to track which classes/instructors are the most popular, what products members use the most, and which members might need a notification sent to their phone to motivate them to use the product. This data gathering and analysis implementation leads to better, more desirable end-products, and, for manufacturers, a more comprehensive understanding of what materials to produce.

[6] Manufacturing Advocacy and Growth Network. (2021). "A blueprint for manufacturing in Northeast Ohio." *Make it Better.*

[7] Arcot, R. V. (2019). "Digital twin helps push manufacturing-performance boundaries." *International Society of Automation*.

ADOPTION PROCESS

To inspire a more widespread adoption of Industry 4.0 in our regional economy, we should analyze what led to the adoptions of 3.0 and 4.0 technologies elsewhere. In doing so, trends between the 3.0 and 4.0 adoptions appear. For example, value creation is a key motivator for those who adopted 4.0 technologies. Value can be created in any number of ways, such as increasing productivity or reducing energy consumption. Creating this value internally allows the manufacturer to offer additional value to customers through faster delivery (increased productivity) and lower costs (reduced energy consumption in production).[8] Consequently, 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 is often the difference in gaining business or losing it to someone else, whether through additive manufacturing and the ability to 3D print a custom output or through highly complex and precise processes that meet specific tolerances. 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 provided 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 other choice. Larger companies are more likely to adopt new processes, thereby putting pressure on small- 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 (i.e., 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 receptive to change and adopting new technologies allows for more efficient planning, faster response time, improved business performance, self-service for customer inquiries, and higher employee engagement and retention. Conversely, companies that refuse to change will eventually lose their customers, employees, and competitive edge.

Compatibility, or whether the concept of change 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, the 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). "A blueprint for manufacturing in Northeast Ohio." *Make it Better.*

[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 more adaptable companies.[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 aremust be more risk-averse than large, multi-national conglomerates because there is less disposable income to spend on implementation and training, especially on technology with long-term returns on investment. 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. Therefore, small- and medium-sized firms should look to larger firms' early adoption of Industry 4.0 as a testing phase, and then identify which processes are worth exploring further because they will save money while allowing the companies 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 is difficult to imagine a factory without any computers successfully competing in the same sector against more 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.

Finally, the ongoing labor shortage has introduced an additional dilemma into the adoption process; firms are struggling to hire skilled workers that understand and can implement highly technical systems. Nonetheless, 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. Small- 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 lagtime with which these small- 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.