



Why digital factories are the future of manufacturing

Deliver real world impact: faster speed to market, more agile processes, increased customization—and more



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Introduction

The past several years have taken manufacturing to the next level, handing processes over to technology, smart machines, and [artificial intelligence](#) (AI). These transformations often happen in isolation, creating siloed environments that miss the bigger purpose of digitalization. But when a company connects data among people, programs, and processes, the sum creates a digital factory.

A digital factory represents far more than the physical process of making things: it's a concept in which the factory itself is figured into the equation. The goal of a digital factory is to optimize manufacturing processes and the environment that houses them.

Powered by data connectivity, digital factories enable cross-functional coordination, create greater agility to adapt to the changing world, and give companies a competitive edge. They are the apex of digital transformation for the manufacturing industry.

Taking the first steps are simple in concept, but, as in most manufacturing processes, complex in detail. They include:

01

Embracing a digital culture and leading with a data-centered mindset

02

Accelerating [digital transformation](#) across the organization

03

Investing in [cloud-based platforms](#) to create common data environments

04

Leaning into automation and digital processes to do more with fewer workers

“

Wilo is now fully leveraging the potential of data transparency across the organization. Our engineers are currently becoming more and more creative to use the available data to further reduce time to market, improve production efficiency, and address many more topics.”

Dr. Mustafa Mahmud Al-Haj, Senior Vice President Group Operations, Wilo SE

Defining the digital factory

A digital factory is a shared virtual model of key factory characteristics—such as geometry, behavior, and performance—that displays the convergence of all digital networks in the facility and its operation. This digital representation compiles data from the structure, systems, assets, and processes, providing you with insights into how to plan, build, and operate your facilities; how to reconfigure them; and how to maximize the efficiency and productivity of every asset.

Digital factories apply the same principles used to optimize the product-development lifecycle—thought leadership, systems, theories, and methods—to the lifecycle of the factory itself. They also allow companies to simulate what-if scenarios to identify opportunities to upgrade the functions of the manufacturing environment.



Companies rely on digital factories to help them:

01

Make better products

02

Attract more customers

03

Improve operational efficiency and sustainability

04

Increase innovation

05

Speed up time to market

06

Gain actionable insights

Their intuitive ecosystems are powered by data and enhanced by human ingenuity, helping you adapt to volatility and grow more resilient in the face of disruption.

The 5 advantages of digitalization

Optimism. Resiliency. Confidence. These are the feelings shared by manufacturing leaders as they look to the future. Whether you've fully embraced your journey to digital transformation or are just getting started, you must recognize the need to be more agile and adaptable.

Digitalization gives you the tools you need to collect enterprise-wide data that can get your manufacturing operation unstuck and create growth opportunities, like:



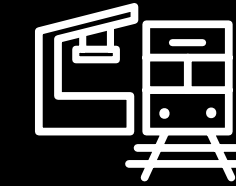
Optimizing factory design

Digital factories support lean operations by eliminating redundant behaviors, consolidating workflows, and automating processes, resulting in lower costs and increasing time employees can spend on value-adding work.

The ultimate vision of a digital factory integrates everything and everyone—shop floor, building, infrastructure, suppliers, vendors, and stakeholders—creating a connected data flow. From that integrated foundation, you can automate, predict, and create a certain intelligence that maximizes efficiency across the entire operation.

With a digital factory, owners can simulate alternatives to find more efficient ways of achieving goals.

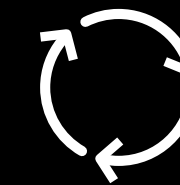
Seven common areas of waste are often associated with manufacturing:



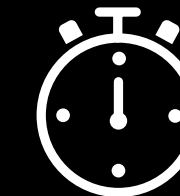
Transportation



Inventory



Motion



Waiting



Overproduction



Overprocessing



Defects

Porsche has a long history of innovation, rolling out its first commercially available high-performance sports car, the 356, on June 8, 1948. The company has come a long way since those first 52 cars were hand-built in an Austrian garage. Today, in one of Porsche's newest factories, a driverless transport system (called Flex-Line) is a modernized assembly line in which autonomous vehicles move cars from station to station, enabling customization to each order.

The company created an integrated planning model to digitally lay out every detail of the carbon-neutral factory and then iterated the design to meet the desired specifications, such as the weight-bearing loads of the floor (615 pounds per square foot). Suppliers could also access the model to configure their equipment to Porsche's space, ensuring collision-free production lines. Today, the Stuttgart, Germany, factory is in full swing, with the virtual model guiding operational improvement. The result? A digital factory that's greener, smarter, and leaner—what the company calls Porsche Production 4.0.

[→ Learn more](#)

Boosting throughput

Recently, manufacturing experienced a surge in demand, reaching a [37-year high](#) in activity. In fact, the manufacturing industry is on track to surpass [pre-pandemic](#) production levels. But it's not just demand that's evolving; what consumers want is changing, too. Mass customization is rapidly becoming a must-have capability for manufacturers. Consumers will pay more for products they can put their personal stamp on.

With a digital factory, you can prepare yourself to meet this growing demand for customized products, using small-batch runs or adding features to an existing offering. One customer might order 1 million standard pens, for example, while another may want 1,000 pens made out of titanium. A third customer could request 10,000 green pens. Through digitalization, you can easily customize each order—making different design and manufacturing choices, while maintaining, or even increasing, throughput. And that's a powerful competitive advantage.



Greater agility

As the past few years have shown, stability is never guaranteed. But even as the manufacturing environment continues to improve, companies need to become even more agile, prepared for whatever disruption event may occur next, in the economy and the world.

Digital factories enable flexible manufacturing. With smart machines, you can be more resourceful and quickly find alternative solutions to change course, make modifications, or adapt to new scenarios. If supply-chain problems disrupt your part supply, you can make it in-house or connect with another manufacturer. With this flexible model, you'll be able to create solutions that lead to new revenue streams, more innovation, and fewer disruptions.



Brioche Pasquier has followed an enviable trajectory from small family bakery to international food manufacturer of French delights, such as its signature brioche rolls. To ensure the consistency of its products as the company scaled and decentralized production, Brioche Pasquier digitized its factories to coordinate operations across the business's 18 international production sites.

Connected through the cloud, European facilities can inform the design of new factories. Information from each location is integrated into 3D digital representations with Autodesk Navisworks and shared across the company so other engineers can use these digital models as a reference. This digital factory approach ensures consistency and connects everyone, from the physical manufacturing operation to the business side of the company.

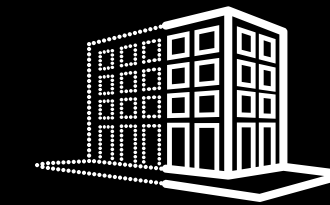
[→ Learn more](#)

Achieving sustainability goals

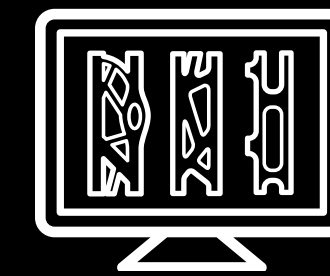
Manufacturing might create the goods consumers want and need, but there are environmental costs to creating those products. According to the [World Economic Forum](#), as a whole, our industry generates 20% of global emissions and is responsible for 54% of the world's energy consumption.

With a data-driven operation, you can uncover more insights that can help you meet your sustainability goals—defined by industry standards, state or federal governments, or your own leadership. Some of your peers are even adding a sustainability role to the C-suite, dedicated to tracking performance metrics, spearheading green policies, and ensuring the company stays in compliance.

A digital factory facilitates more sustainable operations through technology:



Digital twins generate real-time actionable insights so owners can make more sustainable choices.



Generative design allows engineers to find environmentally friendly options (like raw materials) in the design and build of their digital factory and surrounding infrastructure.



Automated systems and AI track energy usage data (like heat) within a space, based on human behavior.

For companies with net-zero goals, a digital factory is the way forward. According to the [PwC Digital Factory Transformation Survey 2022](#), the importance of sustainability as a key driver for digital transformation rose by 150% on average.



Faster time to market

In manufacturing, companies are often focused on the product lifecycle—but there’s a factory lifecycle, too. To maximize productivity, the environment where the manufacturing happens needs to be optimized. And that’s the whole purpose of digitalization. Thanks to automation and a connected ecosystem, information moves faster in a digital factory than in traditional manufacturing.

When your factory is digital, you can leverage insights for a faster design and engineering process, iterate solutions, and make rapid decisions. [The World Economic Forum](#) found that the most digitally advanced manufacturing companies (a consortium it calls the Global Lighthouse Network) increase their speed to market by as much as 89%.

A 4-phased approach

Whether you're building a new operation or reconfiguring an existing one, it's important to follow a phased approach to creating a digital factory:

01

Plan

02

Design

03

Build

04

Operate





Plan

Planning a digital factory begins with logistics and laying out the operation. Start by breaking down workflows step-by-step to determine each station location, equipment placement, and a configuration that maximizes productivity. If digital transformation is underway, you may already have an extensive library of items that can go into the factory.

As the manufacturing industry continues to increase in complexity, the people, processes, and technologies involved must become more connected than ever before. You'll need a planning environment that provides visibility to every stakeholder to help you achieve greater budget and scheduling certainty.

With a common data environment (CDE that connects teams across disciplines, you can capture every design, construction, and manufacturing decision from the beginning.

You can apply lessons from your last factory project to your current one, so everyone can learn. You can improve documentation of existing conditions, revealing potential risk areas. And you can better integrate the factory envelope with the machines inside, increasing project predictability as well as potential cost savings.

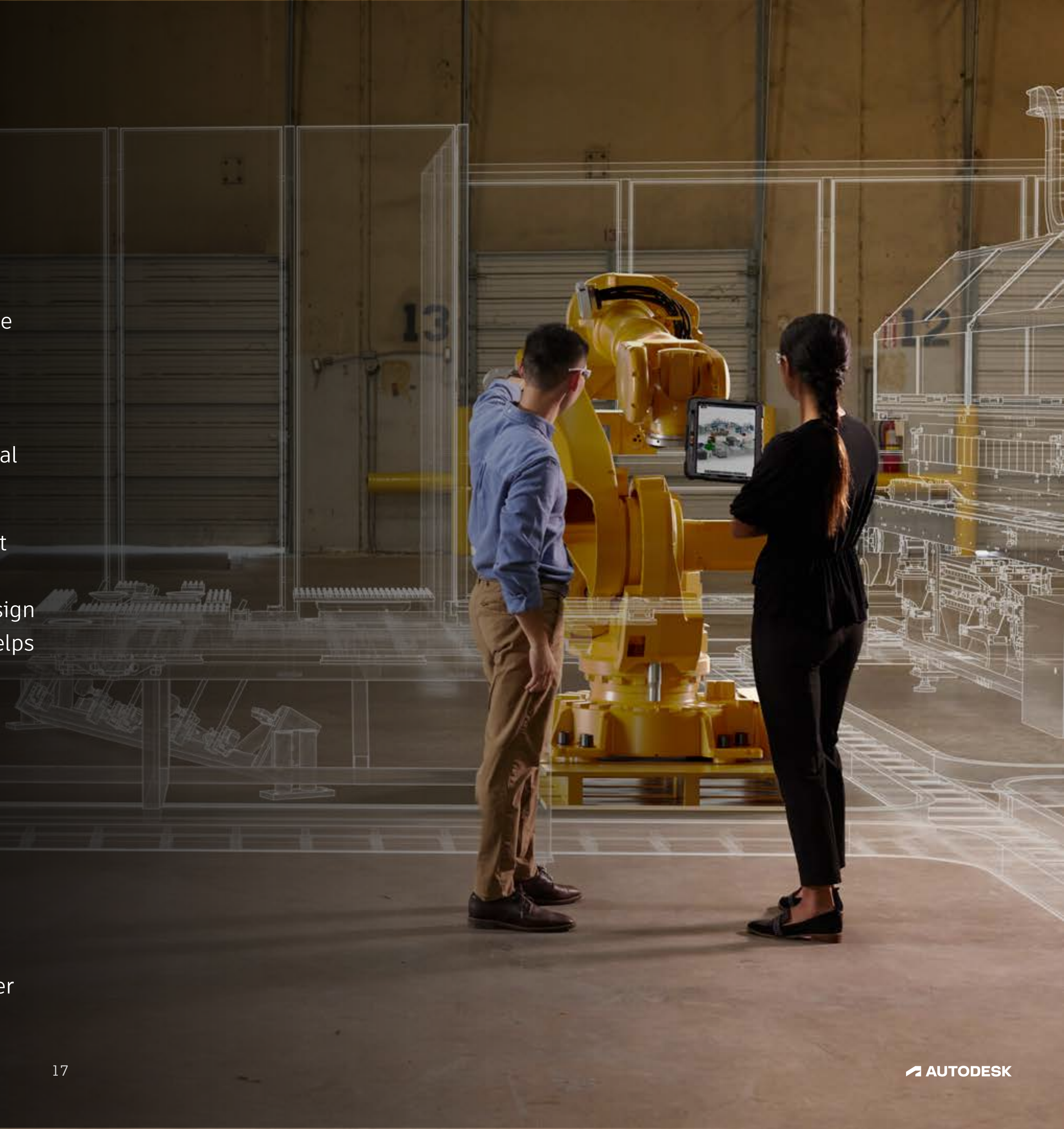
Design

After the planning phase, you'll have a sense of the manufacturing framework as you begin to design the digital factory. Engineers determine how to lay the plan out in the physical space. They'll simulate the movements of people, machines, and materials to determine the most efficient space allocation to eliminate bottlenecks for a faster time to market. Designers will also integrate suppliers and vendors into the digital coordination of the factory.

All stakeholders review the design to ensure its viability and validate that the layout will work. Virtual reality can bring the factory to life, helping stakeholders visualize the space and make revisions if needed. In the design phase, you're aligning the design with the intent of the operation. This helps uncover clash detections and sort out any problems in advance, ensuring you're working toward the best outcomes.

Any stakeholders in the factory also need to pull from the same plan to design their specific area. This might include an ergonomics team that evaluates workstations or the HVAC team mapping the movement of air throughout the facility.

These factories are massive buildings with large machinery and many moving parts. A digital plan allows installation issues to be seen early, resulting in fewer errors during the build and operation phases, and faster path to operations.





Build

Next up: construct the digital factory. This is a digitally orchestrated process, using technology such as building information modeling (BIM) to coordinate between multiple teams—architects, engineers, and contractors—and reduce the risk of cost and schedule overruns. A construction cloud platform creates a common data environment and a single source of truth for every stakeholder to work from.

Virtual reality can also bring the factory to life, helping stakeholders visualize the space and make revisions if needed, and uncovering clashes in advance, ensuring you're working toward the best outcome.

With a detailed construction sequence, you can organize and streamline the build process. BIM tools coordinate logistics while visualizations simulate the layout to test and retest the movement throughout the space and workflows. When everything is installed in the factory, you connect all the stations together and power it up. Then, you ramp up production until you hit the output you need. The digital factory begins to generate a feedback loop with actionable insights.

Operate

Your digital factory is up and running, pulsing with data that flows freely among people, programs, and processes. You have a digital twin that sits on top of the physical asset, tying all the information together and allowing different programs and networks to communicate. This virtual representation gives you an overview of your entire operation and helps you see the impact of every decision.

Empowered with all your new information, you can continually optimize a facility for its entire lifecycle, even adjusting specific production runs. For example, if you discover you need 10% more product for a customer's order, but you calculated only a 5% overage, you can refer to your virtual model to reorganize the production line and adjust the output.

Operation is responsible for approximately 80–90% of a building's cost. A digital factory is designed to reduce those costs by delivering deep insights. Machine learning and automation can facilitate predictive maintenance, alerting workers to an issue before a piece of equipment malfunctions—and saving you from unexpected downtime (which costs manufacturers \$50 billion a year), and keeps production moving without disruption.





Looking to the future

According to a recent [report on digital factories from PwC](#), companies that invest more than 3% of their net annual revenue in factory transformation are 2.5 times more likely to achieve high returns than those who invest less than 2%. But what would a future with a digital factory landscape look like? Here's a quick glimpse.

Making manufacturing more human-centric

Right now, the concept of a digital factory is built around technology, machines, tools, and robots. But it all comes down to what these machines contribute: data. The future of digital factories is converging data from multiple sources and asking, "What does this combined data reveal?" Connected data leads to more than smart manufacturing: It will create intelligent manufacturing. A smart factory gives you the information to take specific action for optimizing your factory and achieving a certain quality. With intelligent manufacturing, the factory will use data to make decisions, too—like machines that can sense when something's not right and course-correct independently.

Infusing manufacturing with transparency

Where will all this data live? On platforms in the cloud, where this live-action view enables 360-degree visibility of an operation. Besides simply breaking down silos, platforms will also become more powerful, extending beyond the walls of the digital factory, through technologies like digital twins and AI-powered insights, to support your entire operation.

Design and make platforms like the Autodesk Fusion industry cloud will provide a single source of project data across your organization and supply chain through a unified data model. By ensuring everyone has access to the same data, you can eliminate repetitive tasks and processes, accelerate productivity, and provide critical real-time insights about product development and business operations.

In addition, you can also extend that data environment to suppliers, vendors, contractors, and other stakeholders. This means they can all work off the same data, at the same time, creating the ultimate vehicle for collaboration. And as manufacturing-led companies increasingly become data-led organizations, these platforms will need to be built on a foundation of trust—providing a secure, reliable, resilient, and scalable solution.

Building more resilience into the supply chain

According to the National Association of Manufacturers (NAM), [siloed data](#) is still a top reason companies experience supply-chain issues. Only [21%](#) of small manufacturers have confidence in the visibility of their supply-chain network. Digital factories remedy this by allowing these smaller enterprises to work together.

In the future, digital factories will facilitate cooperative networks so companies can share equipment, pool resources, and strengthen resilience for individual companies and the industry.

Distributed manufacturing decentralizes materials and fabrication and empowers smaller companies to reap the rewards of digital connectivity. Globally, 98% of manufacturing companies are small- to medium-size enterprises (SMEs.) But when it comes to digitalization, SMEs often lack the capital to invest in Industry 4.0 at the speed and scale of larger competitors. With distributed manufacturing, these businesses can come together virtually, acting as one large organization with the same strength as a massive factory enterprise.



Bridging the skills gap with automation

Digital factories will change manufacturing processes—and the nature of manufacturing jobs. And that’s a good thing. Right now:

10%

Over the next three to five years, many manufacturers will face an employee turnover rate of more than 10%, simply due to retirement.

\$1tn

At the current rate, 2.1 million manufacturing jobs will go unfilled by 2030, costing the industry [\\$1 trillion](#).

70%

70% of companies we talk to think that AI will drive significant or fundamental change in engineering, production, and procurement to fill that gap.

Why is this happening? Workers reaching retirement age outnumber those entering the industry. The automated workflows inside digital factories will help manufacturers close the labor gap, allowing them to do more—more quickly—with fewer, highly skilled workers.



Accelerating gains in sustainability

Back in 2019, we asked manufacturers about their sustainability goals—and 52% confirmed that they had made those goals public. Two years later, that number increased to 75%. And according to PwC, today sustainability's importance as a key driver of digital transformation has risen 150% year over year. But for some organizations, the gap between having a goal and achieving a real-world outcome can be quite broad.

Sustainable manufacturing can help you get there, through a systemic overhaul of industrial processes to analyze and reduce the amount of energy, materials, and transportation time and effort you spend on making products.

The process begins with data—analyzing supply chains, factory performance, real estate footprints, and transportation and logistics. On the factory floor, the rapid adoption of more automation and robotics can become a source of more efficiency. Half the electric power in the United States powers electric motors, the workhorses of industrial processes; adopting renewable power at manufacturing sites can greatly reduce emissions.

Sustainability hasn't just gained currency among climate activists. Its wholesale appeal—cleaner, less carbon-intensive, and often cheaper products—has brought everyone from consumers to bankers to regulators on board. And the trend will only accelerate.

The future is closer than you think

Like many transformations, the move to digital factories can be made incrementally while still delivering near-term impact. Organizations who choose to evolve their processes will recognize the benefits of a more data-centric approach throughout the design, build, and operation phases of the factory lifecycle and embrace change accordingly. The outcomes around design optimization, throughput and customization gains, agility, sustainability, and speed to market will compound quickly.

Owners will have access to the exact information they need, when they need it. Business decision-makers will be more-informed and able to identify and respond to challenges before they happen. Production lines will become more resilient in an unpredictable world. And organizations will be able to outthink—and outmaneuver—their competition.



Explore digital factory solutions from Autodesk

As the industry continues to evolve toward a fully digital factory, the decisions you make now—the approaches you choose, the technologies you adopt, the companies you partner with—will have tremendous impact in just the next few years.

With a robust foundation of integrated digital factory technologies—like layout and design toolsets, simulation, data and process management, digital twins, and more—Autodesk can provide you with the critical information you need to better design, build, and operate your facilities; to reconfigure them more quickly; and to maximize the efficiency and productivity of every asset throughout the factory lifecycle. All so you can meet today's digital factory challenges and be ready for tomorrow's.

