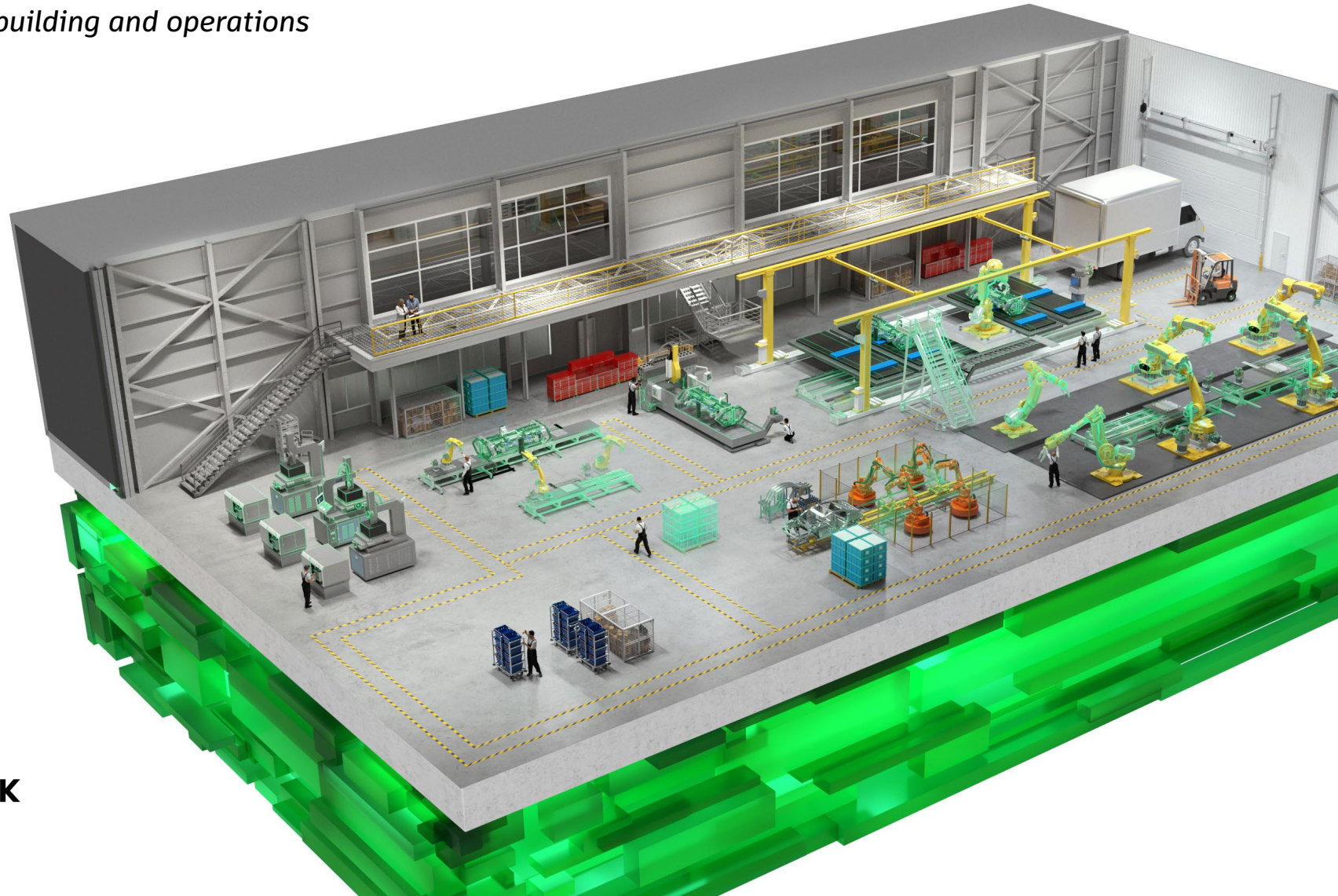
A STATE OF DESIGN & MAKE SPECIAL EDITION

Spotlight on Digital Factories

From planning and design to building and operations



2024 STATE OF DESIGN & MAKE

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Introduction

Today's factories are more data-driven than ever, and the pace at which technology is advancing means that factories falling behind on their digital transformation journeys are falling behind their competitors. Digital factories enable people, machines, and data to work together, creating a connected data flow that integrates everything and everyone from architects, planners, buildings, and infrastructure to suppliers, vendors, employees, and partners.

Data and data management play a key role at every level of the digital factory, from planning and design to building and operations. Whether modernizing brownfield sites or digitizing an efficient greenfield build, companies can use data and technology to help automate processes, predict future needs, and refine product lifecycles to enable better decision-making and better outcomes. And with the increasing use of artificial intelligence (AI) in the factory setting—in the form of digital twins, advanced BIM (building information modeling), and 3D modeling—proper data management will be more important than ever.

But implementation remains a struggle across the factory setting. In fact, 31% of leaders surveyed for Autodesk's *2024 State of Design & Make* report in the automotive, process manufacturing, building products, and industrial machinery industries said that data automation, technological advancements, and digitization is their biggest organizational challenge, even more than cost. Adding to the complexity of digital transformation itself is a growing skills gap—one that is only getting wider as demand for data skills grows across Design and Make industries.

To overcome these roadblocks, organizations need to focus on investing in the people, processes, and technology that will allow them to achieve their digital transformation goals. The digital factory requires even more innovation, more stakeholder collaboration, and much wider access to data to empower dynamic decision-making across the entire factory value chain.

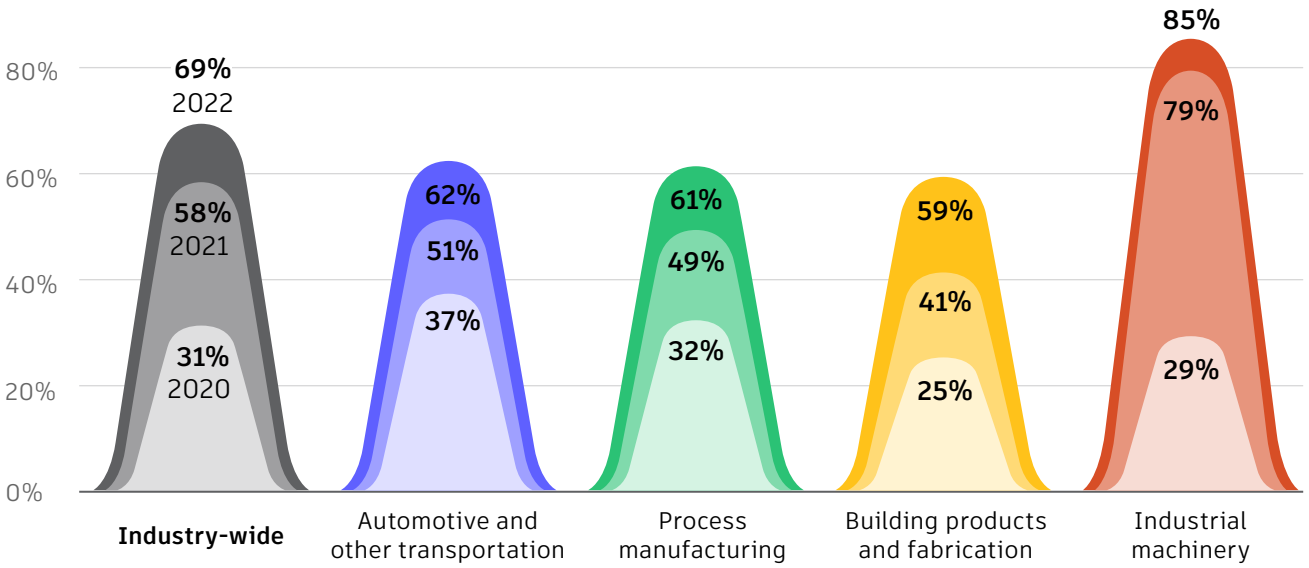
The digital factory advantage

Manufacturing is enjoying a worldwide renaissance that is fueling optimism for factory leaders. Nearly all (93%) leaders surveyed for the *2024 State of Design & Make* report in automotive, process manufacturing, building products, and industrial machinery organizations feel they are keeping up with the rate of change in their industry, with 69% saying their companies outperformed expectations over the previous year.

"We've made good progress on our digital transformation journey," says Cucu Juanda, head of business systems and automation at PT Sanggar Sarana Baja, an Indonesian manufacturer of heavy machinery and equipment used in mining and other industries. "Business process mapping is already done, and we are now strengthening the business system platforms. A key challenge will be how we change the culture of our customers—they are our partners in this digital system."

Keeping up with the rapid rate of change

Percentage of businesses that outperformed corporate expectations



Survey question: How has your company or organization performed compared to corporate expectations in each of the last 3 years? In 2020, in 2021, in 2022. 5-point scale. Top two = above average performance.

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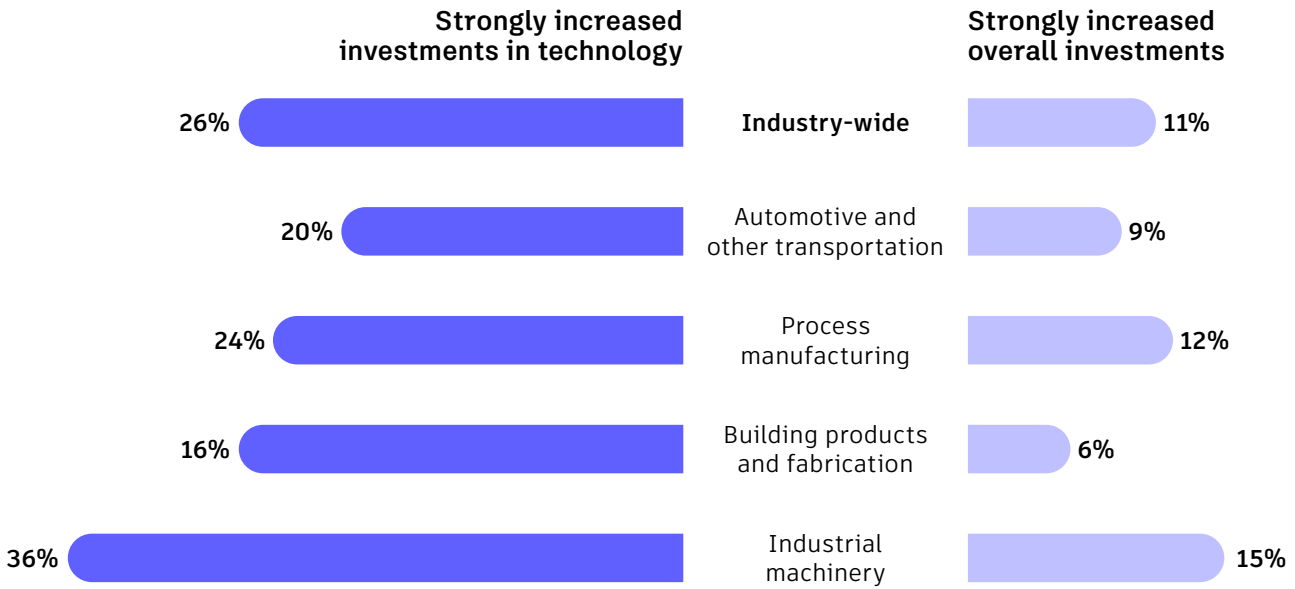
Manufacturers are doubling down on digital transformation

Investment is growing strongly in Design and Make industries



Survey question: How has your company or organization's investment in the following changed over the past 3 years?

This optimism is also spurring increased investment in technology. Twenty-six percent of leaders in automotive, process manufacturing, building products, and industrial machinery organizations say they will increase or strongly increase their investments in technology to deliver improved project outcomes, according to the *2024 State of Design & Make* survey. In addition, 80% will increase overall investments over the next three years.

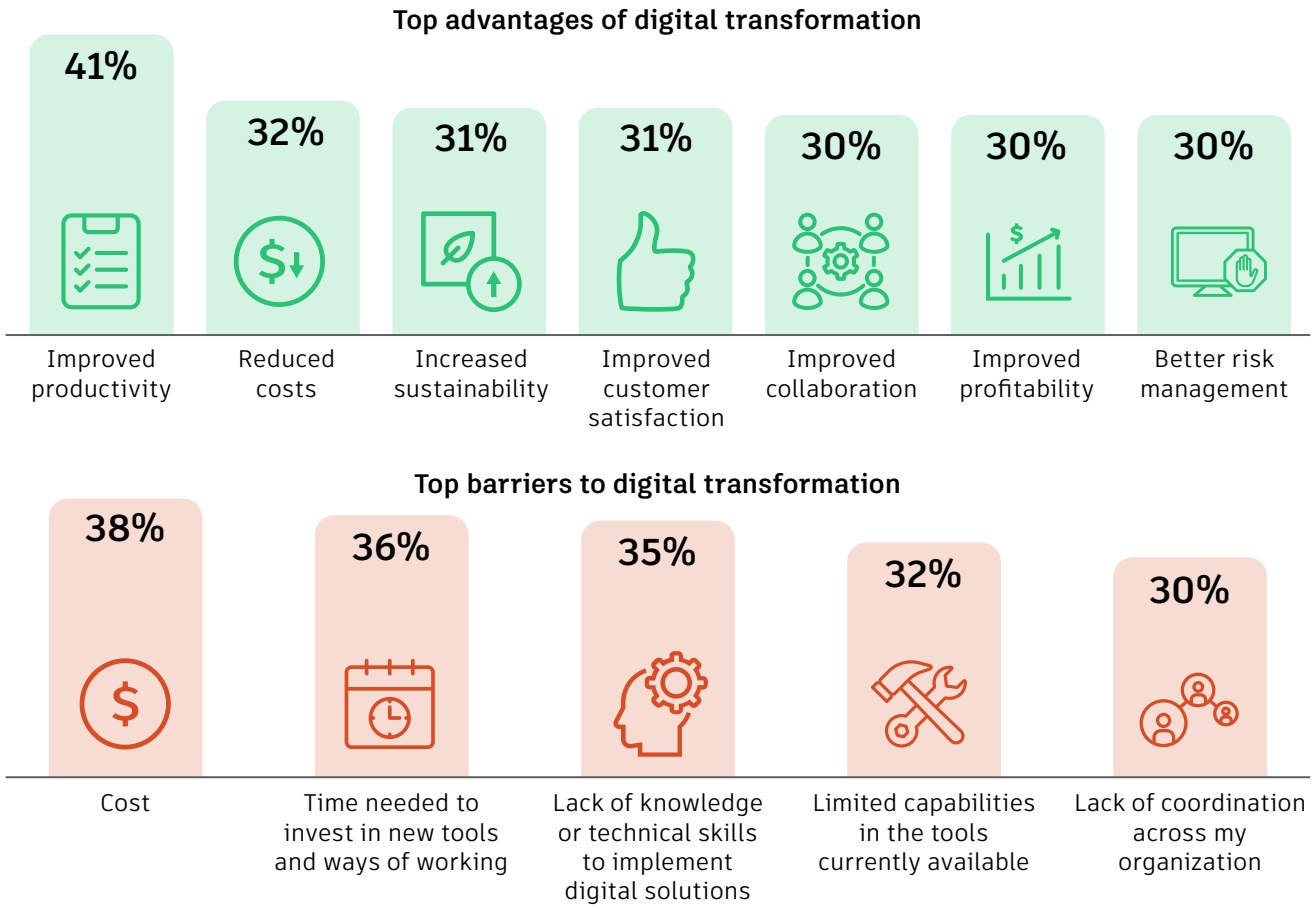
Investments in data and advanced technologies create a flywheel of improvement across digital factories, everywhere from reducing costs to mitigating risks. The top benefit is an increase in productivity, cited by 41% of factory survey respondents who say they benefited from digital transformation. Those same leaders rate the effect of digital transformation as improving productivity by an impressive 62%.

For example, GEA is automating factories that build its large-scale industrial processing systems for the food, dairy, beverages, and other industries. Many of these systems use similar components, such as pumps and valves. GEA's OneEngineering program gives internal teams the ability to adjust design parameters to create custom systems automatically from standard components, reducing engineering time from three weeks to two hours.

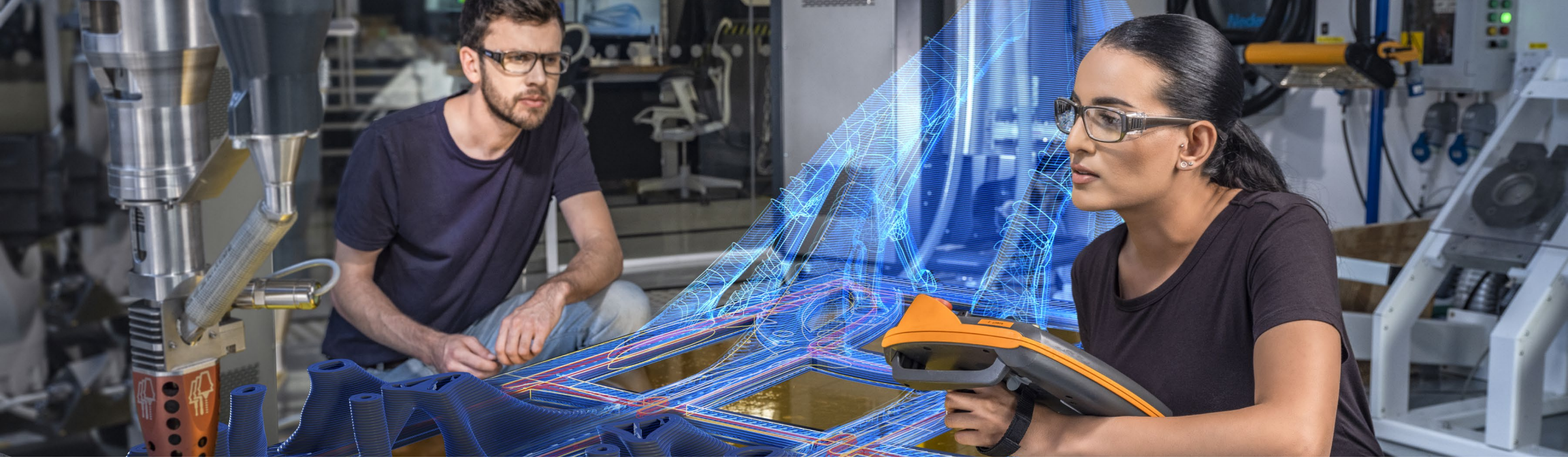
"We've been on this digital transformation journey for many years," says Dave Amantea, chief design officer at Automobili Pininfarina, a luxury electric vehicle manufacturer. "It's really come to life over the past year and energized the business. It's become a Trojan horse for driving other changes, because that vision has gotten so much clearer."

Cost control is top of mind for leaders in factory industries, with 30% saying it's a top challenge at their organization. Digital transformation eases these concerns considerably, with leaders saying it reduced costs by 51% at their organization. For example, manufacturers often employ contingency budgets to account for excessive downtime, unexpected lead time, unplanned line stoppages, and many other unforeseen risks. Digital tools can create nimble design processes, employing extensive simulation practices, simplifying manufacturing steps, and improving quality controls, reducing the budget needed for contingencies.

Digital transformation boosts results



Top ranked response to survey question: Has your company or organization experienced any of the following benefits of digital transformation?
Top ranked response to survey question: What are the barriers to digital transformation in your company or organization?



THE DIGITAL FACTORY ADVANTAGE

Based in Lebanon and operating around the world, Technica International specializes in designing and building advanced automation and product-handling systems. By adopting digital design solutions, the company dramatically improved efficiency—cutting design time in half and reducing costly errors. Engineers can reuse standard components instead of duplicating work, saving both time and money. On top of that, the company loses much less production time correcting errors because employees across functions and roles are able to collaborate using a common source of accurate data.

Manufacturers leading in digital transformation can work in a virtual environment, enabling them to design, simulate, and refine factory layouts, workflows, and resource use before making physical changes. This digital-first approach maximizes efficiencies—reducing material waste, optimizing energy consumption, and lowering carbon emissions. It also helps predict maintenance needs, minimize downtime, optimize supply chains, and extend equipment lifespan for a more sustainable and cost-effective factory operation. And the impact of digitization on sustainability efforts is striking: Leaders surveyed for the *2024 State of Design & Make* report say that digital transformation has increased sustainability by 61% at their organization.

Optimizing production through the smart use of data can lead to a host of positive environmental changes. For example, Porsche's digital smart factory for its electric Taycan sports car in Stuttgart, Germany, is a "zero-impact facility" designed to leave no environmental imprint. It takes a holistic approach to resource consumption and waste, incorporating a green roof, biogas, photovoltaic systems, and other renewable-energy sources. Everything down to the robots and even the garbage cans was designed using an integrated planning model that simulates the building and its technology systems.

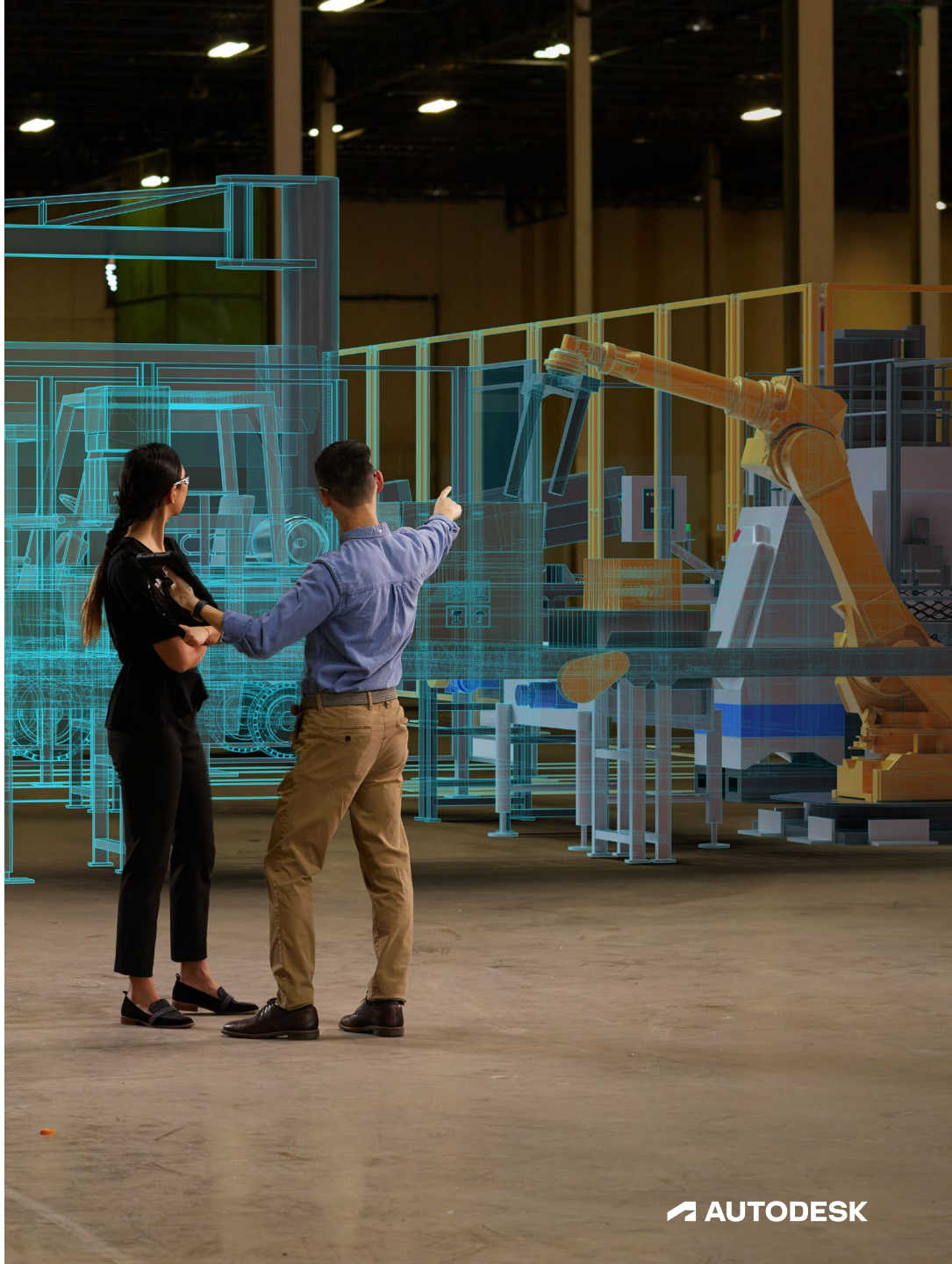
The evolving role of AI in the digital factory

Leaders in Design and Make industries foresee strong results from their increased investments in digital transformation and have especially high hopes for AI in the factory setting.

Most factory leaders trust AI technologies for their industry (79%) and agreed they would make their industry more creative (81%). Most felt that AI would be an essential component over the next two to three years, and half of respondents were already approaching or have achieved their goal of incorporating AI into their companies.

Although adoption of AI in the factory setting is slower than in other industries, AI is finding impact when paired with digital twin technology. VisiConsult, a leading manufacturer of industrial X-ray and computer tomography solutions for quality control, creates digital twins of parts using its powerful X-ray units. Customers can inspect these parts remotely via the cloud, identifying and fixing issues before production. AI further enhances this process by automatically detecting defects more accurately than traditional X-ray methods, continuously improving as it learns from new image data.

Other leaders are taking a more forward-thinking view of AI and see the long-term potential of integration into the factory. “In five years, I hope AI can help us reduce costs, improve productivity, and better forecast demand,” says Clint Allen, senior director of design and reliability engineering at Sherwin-Williams, which manufactures, distributes, and sells paints, coatings, floor coverings, and related products. “AI could also help us develop more efficient production schedules, reducing cross-contamination and increasing overall efficiency.”



Cost, time, and talent top list of challenges for factory digitization

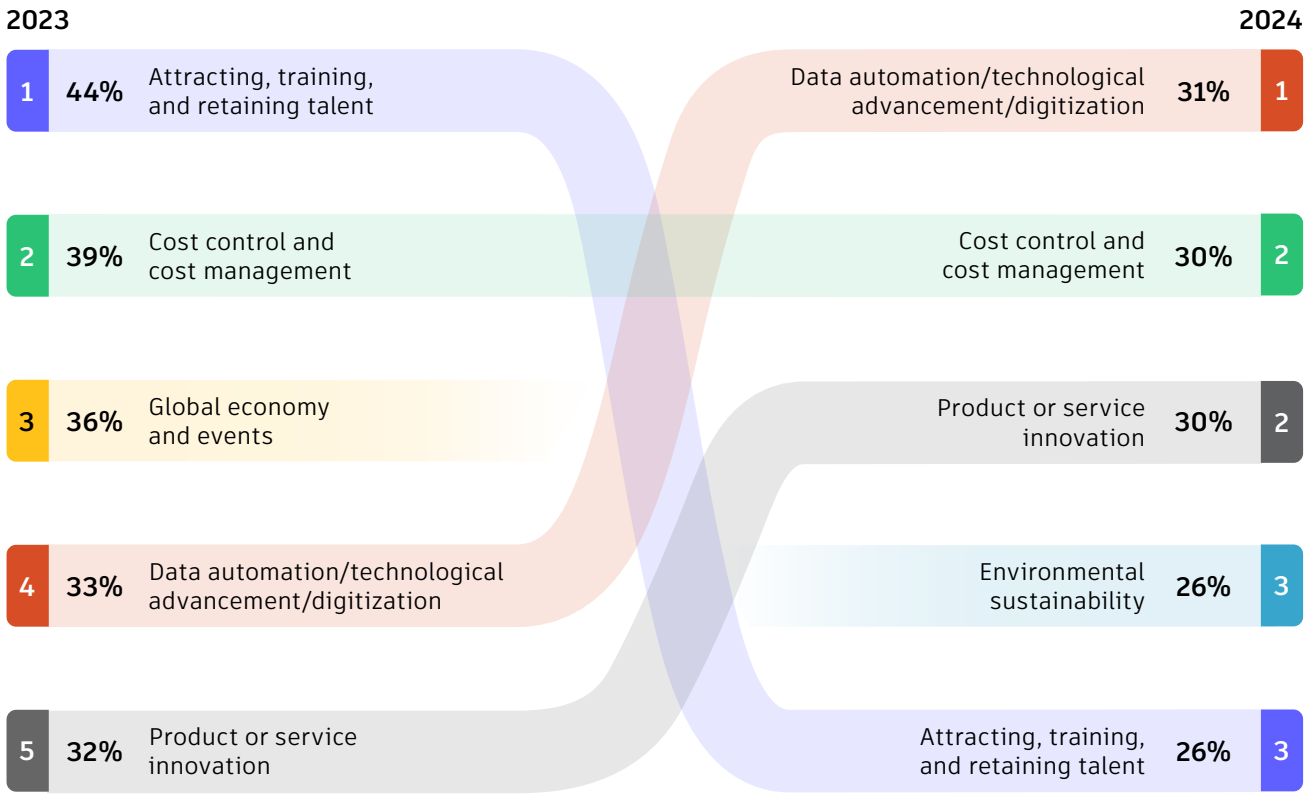
Data automation, technology advancement, and digitization is now the top overall challenge facing factories. Talent concerns have eased but are still considerable, with 26% of factory leaders saying attracting, training, and retaining talent is a challenge, down from 44% in 2023.

These challenges are echoed in digital transformation journeys. Cost is the top barrier for 38% of factory leaders, followed by lack of time to invest in new tools and ways of working (36%) and a lack of knowledge or skills (35%).

While talent concerns in general may be down year-over-year, finding skilled talent remains a persistent issue that will likely be compounded by a tight labor market and scarcity of skills in new technology. Leaders recognize the growing gap between the skills their workforce currently has and the skills they will need in the future.

Data and tech advancements top list of challenges

Top 5 business challenges showing year-over-year change



Survey question: What are the top 3 challenges your company or organization faces today? Select up to three.

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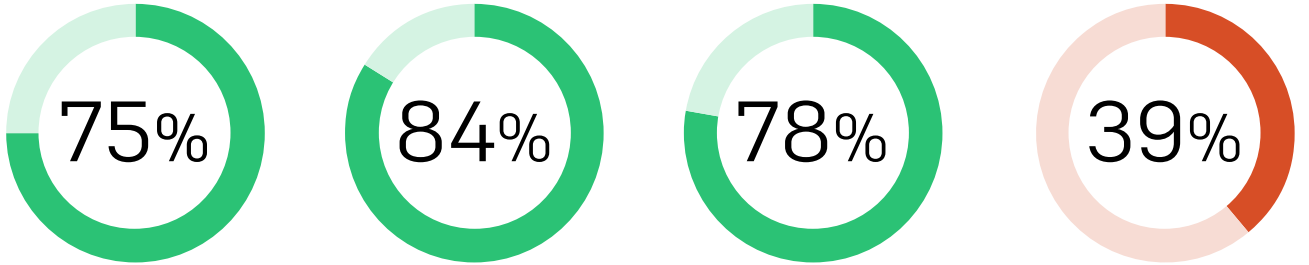
"There is a tightness in the labor market," says Dave Mackenzie, managing principal for digital at Aurecon, an Asia-Pacific engineering, design, and consulting company. "There's a stack of engineering work to be done, and there's probably not enough engineers, especially ones with the expertise that you need. Attracting people to the field is a longer-term issue. How do we grow the talent pool and mentor people to develop into really great engineers? If we don't solve this problem, then we're always going to be in this position."

Allen at Sherwin-Williams sees things similarly. "The biggest challenge is the long-term support of automated systems," he says. "The more you automate, the more technical your resources need to be. This requires engineers who can troubleshoot programmable logic controller [PLC] programming and electrical issues. Training people to be good troubleshooters and technically skilled in various areas is crucial."

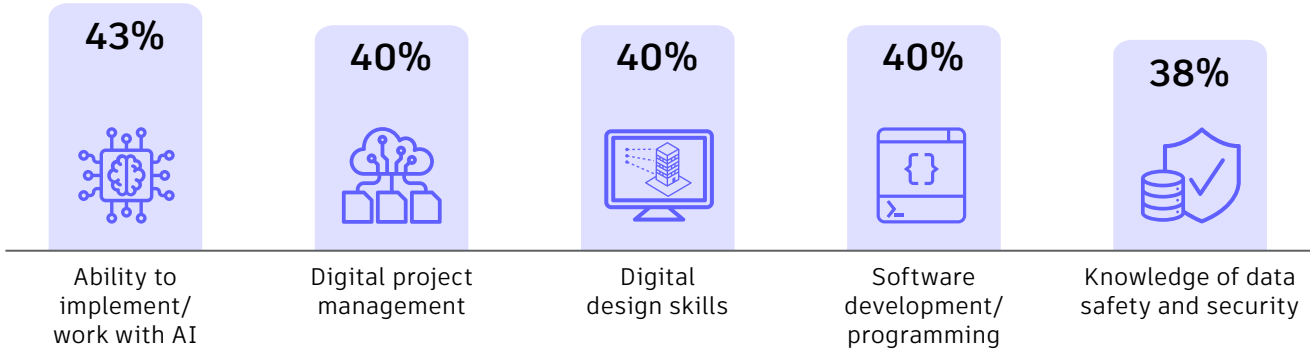
Across industries, factory leaders see workforce training as a solution and see the value in investing in upskilling and continuous learning to address a skills gap. The majority of organizations are implementing continuous learning, and 84% of leaders say upskilling is important. But despite the positive sentiment surrounding upskilling and reskilling, organizations struggle to implement internal training programs.

Leaders agree on the importance of upskilling

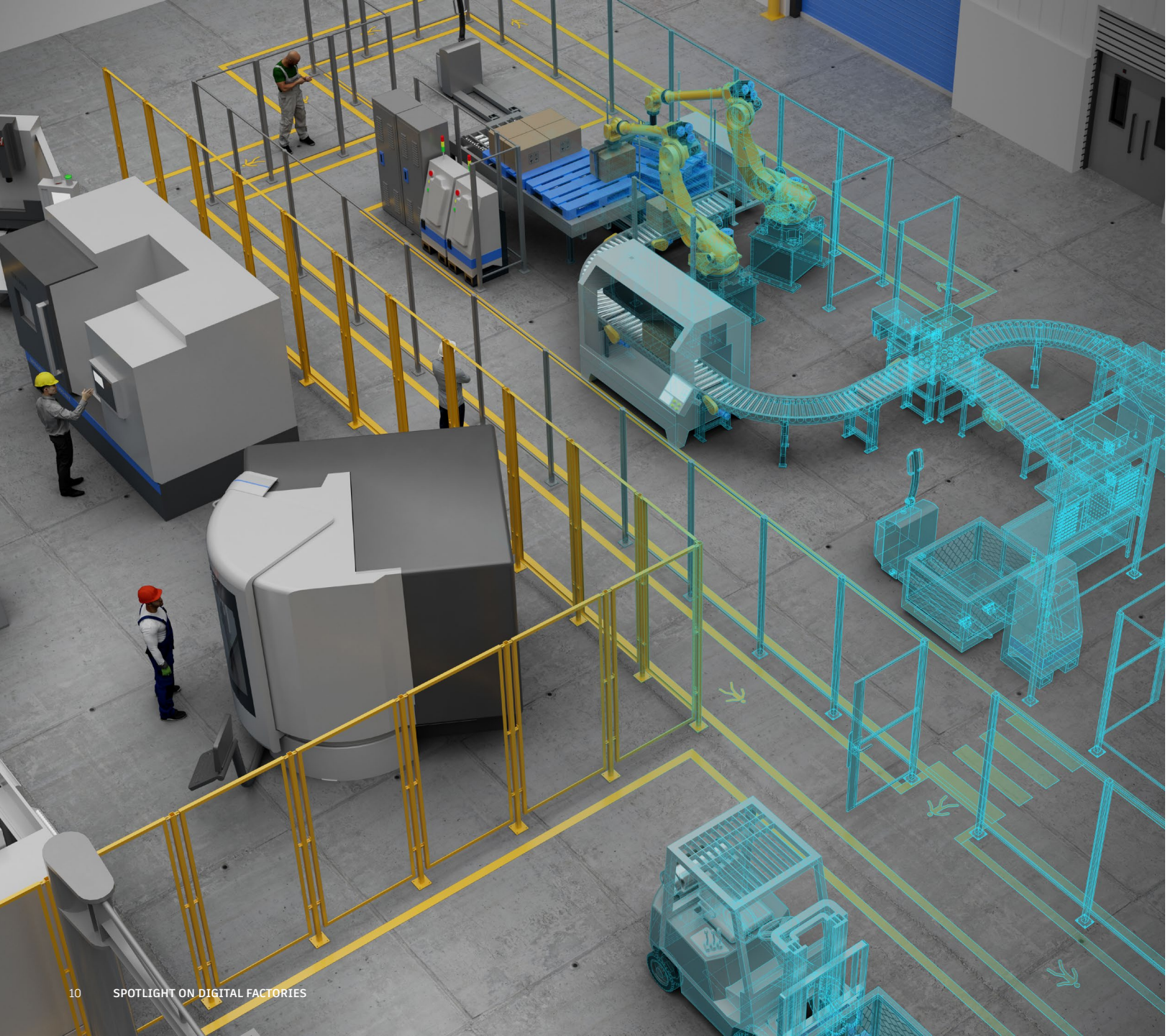
Skills training can address digital transformation challenges



The skills in demand



Survey question: What technical or digital skills do you believe your company or organization will be prioritizing when hiring over the next 3 years? Select all that apply.



COST, TIME, AND TALENT TOP LIST OF CHALLENGES FOR FACTORY DIGITIZATION

With the rapid pace of technological advancement, the skills gap will likely grow. Currently, skills for AI use, digital project management, and digital design are the highest priorities to hire for over the next three years in the factory setting.

Leaders across industries are taking a multipronged approach to solving the talent challenge. Three-quarters say digital maturity and sustainability efforts help them attract and retain talent and improve job satisfaction. Allen of Sherwin-Williams says that organizations need to develop internal partnership programs and mentorship opportunities: “Our plants with union labor benefit from apprenticeship programs that produce skilled workers. Whether through unions or internal programs, creating a pipeline for skilled trades is essential for future success.”

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A more sustainable digital factory

Sustainability has always been a challenge for factories—design and manufacturing (D&M) industries alone account for 20% of the world's carbon emissions, according to the World Economic Forum. But perceptions are shifting: More leaders now see sustainability not as a challenge but as a business opportunity.

The number of executives globally who understand the business case for sustainability tripled between 2022 and 2023, according to the World Economic Forum, and 78% of *2024 State of Design & Make* survey respondents say that sustainability is crucial for future business growth in the next three years. This signals a massive shift in sentiment and priorities, driven by the long-term opportunities that sustainability can provide.

"We've embedded sustainability into everything that we do," says Kim Dabbs, global VP, ESG and social innovation at Steelcase, a furniture manufacturer for offices, hospitals, and classrooms. "It's not just a sustainability team—we had a cross-functional team that built a sustainable design framework, and now everything that we produce goes through that framework. This is critical to changing the entire ecosystem and not just pockets of the ecosystem."

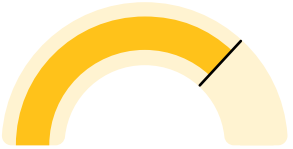
In addition to building factories with more sustainable materials or features, some companies are focused on adaptive reuse—repurposing existing facilities for different uses. For instance, Factory_OS converted an old World War II airplane hangar into a facility to manufacture modular housing, allowing the company to build high-quality homes faster and at a lower cost, with less waste—all while creating good, stable jobs for local construction workers.

Sustainability is critical to digital transformation efforts

Many companies are committed to proactively reducing emissions

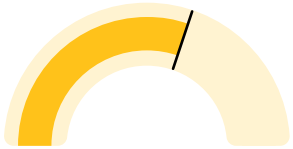
81%

say sustainability initiatives are a key part of their company's **business growth strategy** for the next three years



74%

say that sustainability goals are **no longer a nice to have but a requirement** of modern business



61%

of leaders and experts say sustainability is **good for short-term business**

86%

of leaders and experts say sustainability is **good for long-term business**

Source: *2024 State of Design & Make* report

A MORE SUSTAINABLE DIGITAL FACTORY

Many companies are using digital technologies like AI to achieve sustainability goals. In fact, 34% of leaders in Design and Make industries say they use AI to enable sustainability, more than any other action. For instance, AI plays a transformative role in optimizing energy consumption and driving sustainability through predictive energy management such as energy demand forecasting and peal load management. Companies are using AI to forecast outcomes based on historical data, optimize project timelines, and allocate resources. They can generate hundreds of design alternatives with AI and assess the environmental impact of buildings or designs before getting on-site.

In Design and Make industries, where decisions made at the design stage can influence 80% of a product's environmental impact, AI is helping organizations think about sustainability from conception through production. Decathlon, a French sports equipment manufacturer and retailer, has successfully redesigned the traditional diving fin with a strong focus on sustainability and performance. To create the fin, the firm used generative design software, which employs machine learning and AI to explore multiple design alternatives. The new React fin uses 50% less material and cuts the carbon footprint in half compared to market standards. Moreover, it's designed from a single type of plastic for easier recycling at the end of its lifecycle.

Some factories are adopting digital-twin models of production lines and machines by using tools that simulate systems in a single web environment. With 20 consortium members across Europe, the ECOFACT project aims to create a holistic decision support system for manufacturing industries to use in optimizing the performance of their production systems. The project aims to lower the use of energy, water, and other resources, as well as carbon-dioxide emissions. The systems tap into real-time data from the field to ensure plans, designs, builds, and operating systems remain current and accessible.

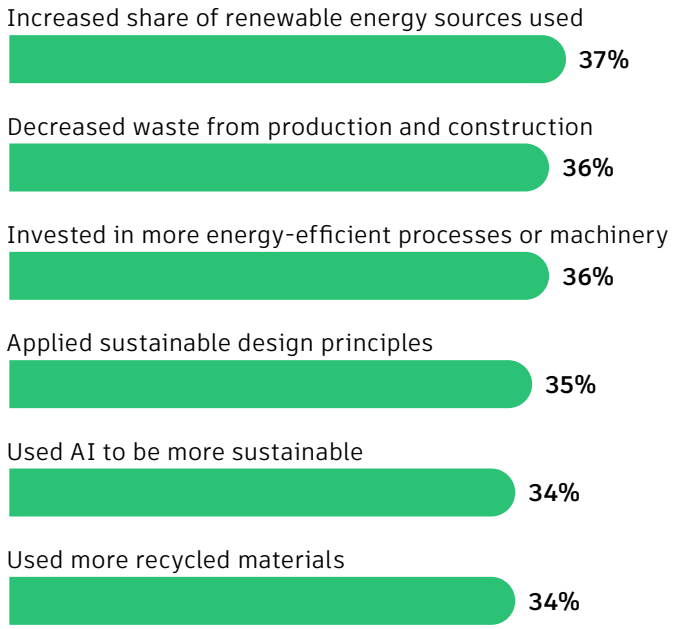
Some leading companies are designing their entire factories with sustainability in mind. “We have invested heavily in standardization and digitization, which has significantly increased our efficiency,” says Henry Huang, GM of International BU at Dongyan Intelligence Design Institute, a provider of solutions for intelligent manufacturing systems. “For instance, our demo project at our headquarters in Wuhan saved 30% on energy costs by integrating solar systems and automated power management. This project won several awards and demonstrated the potential of digital transformation in improving energy efficiency and operational control.”

With the right intention, digital factories can actively support sustainability goals. The Smart Factory by Deloitte @ Wichita, a joint effort from Wichita State University and Deloitte, includes a full-scale production line demonstrating how to join existing manufacturing assets with technologies such as robotics systems, 3D printers, 3D laser scanners, augmented reality/virtual reality assets, simulation and visualization software, and more. The facility is also a net-zero smart building on a smart grid, and the program aims to demonstrate how advanced technologies can streamline operations to reduce environmental impact.

2024 State of Design & Make survey results show that about a third of companies are increasing their sustainability efforts, and that percentage is only expected to grow in the future.

Building a sustainable future

Top results from sustainability efforts



Survey question: What changes has your company or organization already made to be more sustainable? Select all that apply.

Digital factories are built on data

Data is the raw material that helps build digital factories—it's the connective tissue that flows through every step of the digital factory, from planning and design to building and operations.

To keep factories running—on schedule, within budget, and ready for disruption—requires the proper management and democratization of data. Everyone who plays a role in a project's success requires access to granular, interoperable, and accessible data quickly and with minimal friction. Systems and processes should be regularly evaluated for gaps and opportunities for optimization, and assets and operations need to be tracked, managed, and documented from delivery to installation and beyond to ensure quality and maximum efficiency.

As access to data and, more importantly, the ability to manage and use that data increases, the applications in factory settings will continue to increase exponentially. Ultimately, data and data management will become fundamental building blocks for the digital factory, and organizations able to keep a competitive edge will be data-driven and technology-forward.

About *Spotlight on Digital Factories*

Data for the *Spotlight on Digital Factories* report was compiled from Autodesk's *2024 State of Design & Make*. For the 2024 report, Autodesk surveyed 5,368 global industry leaders, futurists, and experts in the architecture, engineering, construction, and operations; design and manufacturing; and media and entertainment industries. This report contains key findings from this research, including details at the sector and regional level.

The *Spotlight on Digital Factories* report includes qualitative interviews from 11 leaders and experts across Design and Make industries.

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