Advanced Manufacturing: Managing the Digital Transformation Journey

How manufacturers can navigate the opportunities
and challenges of adopting new technologies.

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TRAVELERS

Foreword: Making digital transformation your competitive advantage

In November 2009, the National Institute of Standards and Technology (NIST) published a white paper titled "Challenges to Innovation in Advanced Manufacturing." The paper outlined industry drivers and offered research and development needs and recommendations. In the executive summary, the authors stated:

> *"The integrated enterprise that effectively achieves process and personnel safety, environmental protection and superior energy efficiency will realize faster time to market, lower total cost of ownership, excellent asset optimization, effective risk management and economic excellence. These factors will determine the winners in U.S. manufacturing in the next decade."*

More than 10 years later, have we modernized factories? Manufacturers are increasingly looking to new technologies to boost production, improve quality and reduce costs,[1] but it's difficult to say whether or not the factories of today are vastly different from 2009.

Travelers brought together our team of risk management specialists and surveyed our customers to better understand the real-world challenges and opportunities digital transformation presents.

While technology adoption is most often observed in sectors such as hybrid and electric vehicles and pharmaceuticals and high-volume goods,[2] many other manufacturers are under pressure to digitize operations in order to meet the demands of customers' ever-changing need for speed and customization.[3]

Technological progress can be expensive and present challenges. However, many of our manufacturing customers are feeling optimistic about the future, recognizing that digital transformation is indeed a marathon and not a sprint.

Understanding the varied risks and rewards of connecting technology, people and data will help position organizations to reap the benefits of digital integration.

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Brian Gerritsen, Travelers Manufacturing Industry Lead

Adopting technologies brings new risks[4]

Leading a manufacturing company requires an understanding of a wide array of factors, each of which can impact the bottom line and change at any given moment:

- Customer sales and service requirements.
- Attracting skilled labor.
- Increased global competition.
- Supply chain challenges.
- Production and quality control methods.
- Workforce safety demands.
- Sustainability.
- Information security.

To further complicate the picture, today's manufacturers are often navigating technological risks in conjunction with the need to evolve their workforce. Specialized training that keeps pace with new manufacturing technologies can be essential for worker safety and productivity, and for the quality of the end product.

Manufacturers may also face the challenges of:

- Integrating technology into business goals.
- Choosing from an overabundance of technology options.
- Siloed organizational frameworks.

In preparing and planning for technology adoption risks, it's important to understand that once implemented, new technologies may result in an occasional misfire, potentially leading to a data breach, customer or employee injury, property damage or third-party economic loss.

Whether adopted into factory production methods or integrated into finished goods, firms must reevaluate their operational threats with every new technology deployed.

On the pages that follow, Travelers shares insights into the technologies that are transforming the manufacturing industry and the importance of managing the new and evolving risks — from technology adoption to workplace safety — inherent in their implementation.

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Technological advancements

Advances in technology promise many advantages to manufacturers striving to overcome challenges, realize new efficiencies and gain a competitive advantage. The top trends below, collectively termed the Fourth Industrial Revolution[5] or Industry 4.0, are combining to transform the modern manufacturing world.

THE INDUSTRIAL INTERNET OF THINGS (IIoT)

The IIoT brings smart sensors and devices directly onto the manufacturing floor. The IIoT refers to the many internet-connected industrial devices and smart sensors that gather and share data. Local or cloud-based analytic platforms can mine data from these devices for insights that have the potential to help drive better business decisions while improving plant efficiency, reliability and safety.

ROBOTICS

Industrial robots present the prospect of increased productivity, precision and efficiency in the manufacturing environment. Robots can be programmed to perform repetitive tasks and help free up workers for other activities. Collaborative robots, or cobots, work alongside humans to streamline production processes and improve safety.

DATA ANALYTICS

Connected machines and embedded sensors can gather vast quantities of valuable data to provide broad visibility into plant operations. Data analysis software can uncover this data to identify patterns among process steps and inputs, even at a granular level, and reveal important insights, whether on a dashboard, in a report or visualization, or on a device in real time.[6]
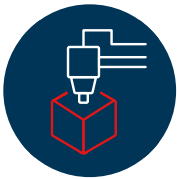
3D AND 4D PRINTING

3D printing builds three-dimensional products one superfine layer at a time directly from computer-aided design (CAD) diagrams. Also known as additive manufacturing, 3D printing is most often used for rapid prototyping but can also be faster and more flexible than traditional manufacturing methods. It can reduce design-to-production time frames and enable on-demand production.[7]
4D printing is poised to augment 3D printing with new materials that can transform over time, using factors such as light, hot water or heat.

AUGMENTED REALITY (AR) AND VIRTUAL REALITY (VR)

AR provides an interactive view of the real world and has growing applications in manufacturing. Using smart glasses, smartphones and other AR devices, workers can access information — such as product assembly instructions, dashboards and equipment maintenance histories — when and where they need it. VR offers similar benefits. With the aid of a headset, an employee is immersed in a virtual training world, setting a foundation for hands-on learning and reducing the risks posed by real-life scenarios.[8]

These and other emerging technologies, such as artificial intelligence and machine learning capabilities, are revolutionizing the manufacturing world.[9] Integrating them into production processes can be daunting as new risks may come with every new technology. But manufacturing companies that make the investment may later benefit from reduced risk, greater productivity, profitability and success in an ever-competitive marketplace.[10]

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Technology engagement among manufacturers

Many manufacturers recognize that digital implementation is essential to future growth. As technologies become less costly, it can be more feasible to move toward advanced manufacturing methods that present the potential to decrease labor costs, increase productivity and reduce error rates on the factory floor.

In the first quarter of 2022, Travelers concluded a 2021 technology survey[11] comprised of thousands of small, midsized and large manufacturers. The findings suggest companies of all sizes are utilizing and accelerating technology adoption.

TECHNOLOGIES CURRENTLY IN USE BY MANUFACTURERS[12]

TECHNOLOGY	ALL MANUFACTURERS COMBINED	SMALL (0–49 EMPLOYEES)	MEDIUM (50–999 EMPLOYEES)	LARGE (1,000–9,999 EMPLOYEES)
Emerging technology	**72%**	**42%**	**72%**	**82%**
Industrial internet of things (IIoT)	**50%**	**22%**	**48%**	**61%**
· Sensors to monitor equipment status	34%	15%	31%	44%
· Sensors to monitor building status/smart buildings	22%	9%	19%	29%
· Employee wearable sensors	16%	4%	15%	20%
Advanced robotics	**49%**	**28%**	**45%**	**60%**
· Automated machines/robotics	38%	21%	33%	50%
· Collaborative machines/robotics	27%	14%	24%	34%
3D/4D printing	**19%**	**10%**	**17%**	**24%**
Cloud-based software	**42%**	**27%**	**37%**	**51%**

TECHNOLOGIES MANUFACTURERS INTEND TO IMPLEMENT (IN THE NEXT 12 MONTHS[13])

TECHNOLOGY	ALL MANUFACTURERS COMBINED	SMALL (0–49 EMPLOYEES)	MEDIUM (50–999 EMPLOYEES)	LARGE (1,000–9,999 EMPLOYEES)
Emerging technology	**48%**	**31%**	**51%**	**48%**
Industrial internet of things (IIoT)	**29%**	**14%**	**30%**	**32%**
· Sensors to monitor equipment status	12%	6%	13%	11%
· Sensors to monitor building status/smart buildings	12%	6%	12%	14%
· Employee wearable sensors	12%	4%	12%	15%
Advanced robotics	**23%**	**13%**	**26%**	**21%**
· Automated machines/robotics	12%	6%	15%	12%
· Collaborative machines/robotics	13%	7%	15%	12%
3D/4D printing	**11%**	**10%**	**11%**	**11%**
Cloud-based software	**12%**	**8%**	**14%**	**11%**

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Areas of technology application

Every point along the manufacturing process can be a candidate for technology adoption. Here are some of the essential ways manufacturers are integrating technology into their operations.

EQUIPMENT MAINTENANCE

Performing equipment maintenance before it's needed can drive costs up and slow productivity. Waiting too long can mean unplanned downtime that disrupts or halts operations and cuts into the bottom line. Smart technology offers an alternative: predictive maintenance informed by condition-based knowledge.[14]

Smart sensors embedded in industrial machines can monitor performance and test various data points such as temperature, speed, vibration and lubrication. When filtered through advanced analytical software, this vital information can help maintenance crews with real-time insights into equipment health, red flags and lead times for scheduling service. This predictive information can significantly reduce downtime and maintenance costs.[15]

> **CURRENT USES**
> *A company in the tech sector was able to correct a consistent problem in microchip production that relied on automatic solder-dispensing equipment. Every so often, a solder machine would fail to deposit any solder at all, resulting in faulty circuit boards that had to be scrapped. Engineers traced the problem to fluctuating vacuum levels in the solder dispensers.*
>
> *Through the installation of sensors, the company was able to correlate machine sensor readings with other connected machines on the production line. As a result, assembly was monitored and controlled more effectively, leading to fewer defects and greater throughput.[16]*

INVENTORY AND SUPPLY CHAIN MANAGEMENT[17]

The COVID-19 pandemic laid bare supply chain limitations — and the need for a faster, more resilient supply chain model. Technology can provide manufacturers with end-to-end visibility over the entire supply chain to help reduce disruption and better manage risk.

Sensors and location-aware technologies, such as radio frequency identification (RFID) tags, can help enable supply chain visibility both within and outside of the plant. They can be attached to parts, storage containers, products and raw materials to trace real-time status, location, environmental conditions and inventory. For example, some sensors can transmit GPS coordinates so a factory knows that a part needed for Wednesday's production run is 300 miles away on Monday but should arrive by Tuesday afternoon.

Data analytics translates data from the many sensors and other devices in the supply chain into actionable insights to help manufacturers:

- Increase visibility and transparency for all involved.
- Plan inventory and forecast demand.
- Optimize supply chain performance.
- Be more responsive to customer needs.

> **CURRENT USES**
> *An automaker has connected sensors in its supply chain to cloud services on a global scale. Now the company can track its inventory en route, whether parts, assemblies or finished vehicles, regardless of country of origin. As a result, the manufacturer benefits from real-time inventory tracking, reduced downtime through improved scheduling and monitoring, and improved customer service.[18]*
>
> *Similarly, a large manufacturer has placed an optical, cloud-based inventory management system adjacent to its supply bins. Through built-in sensors, the system monitors the bins' quantities and sends the data to an enterprise resource planning (ERP) system programmed to alert when reorder points have been reached. The company can then place orders to replenish stock without manually taking inventory.[19]*

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WORKFORCE SAFETY

Sensors can set safety boundaries and maintain restricted areas on the factory floor, and help sound alerts or stop machines when a person or object comes within the sensing field.[26] They can also detect potentially dangerous environmental conditions, such as sensing overheating equipment or unintended gas or vapor releases, and sound audible alarms to prompt an immediate response.[27]

Robots blend into operations with employees to better manage repetitive and potentially hazardous tasks. They can pick products that are placed high on warehouse shelves, lift heavy objects and take over other jobs that pose a risk to employees, such as welding, spraying and working in potentially hazardous environments that normally require respirators or other protective equipment.[28] Robotics and sensors have the potential to help minimize injuries and accidents and reduce the frequency of costly workers compensation claims.

Wearable technology also plays a key role in workplace safety.[29]

- Wearable sensors alert workers to hazards, such as mobile equipment in motion nearby. They can also help to predict worker fatigue, repetitive motion and other physiological conditions that may signal potential accidents or injuries.
- Manufacturers can use the 3D world of VR and AR to simulate safe layout planning. Workers can use this technology to learn essential skills in a safe, interactive environment in conjunction with other on-the-job training tools.

CURRENT USES
Several companies are using new technology to detect gas exposure and alert plant managers of remote safety incidents.[30] The devices can monitor the safety of thousands of employees across a large plant in real time from a central location.[31]

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PRODUCTION PROCESS AND QUALITY CONTROL

Technology can bring efficiencies to nearly every part of the manufacturing organization, but its most direct impact may be on production.

Sensors can help to monitor much of what's going on throughout the production line. They can identify opportunities to increase productivity and provide early warning of conditions that are detrimental to the production process.[20] They can also direct real-time actions when necessary. For example, quality control sensors can detect potentially defective parts and direct a robotic arm to remove them from the line for further inspection.[21]

Robots can perform a range of tasks – from assembly and welding to product inspection and testing – with speed and precision. They can help remove the risk of human error and produce more consistent results.[22]

For instance, cameras and machine vision can identify product flaws that might go unnoticed to the human eye, taking quality control to a new level.[23] Cloud computing can mine the vast amounts of data collected throughout the production process to uncover strategic insights that help manufacturers streamline production and steer future operations.[24]

CURRENT USES
A midsized high-precision manufacturer has no room for error in its production assembly functions. So, the company has implemented its manufacturing execution system, or MES, to help automate production quality control. The software uses sensors to capture highly detailed factory floor data right down to the number of times a screw has been turned.[25] By subdividing and analyzing these data elements, the company can deliver products that adhere to the strictest manufacturing standards.

CUSTOMER AND PRODUCT DEVELOPMENT INSIGHTS

Customers have high expectations of the products they buy. Quality is critical, and product personalization is in increasing demand.[32] If manufacturers hope to meet or exceed expectations, they need accurate insight into customer experiences and preferences. This type of customization may require an agile production environment that is responsive, adaptable and efficient.

Customer data may provide the insights that manufacturers need to inform product updates and drive new product development.[33] Insights can be culled from disparate sources: maintenance and repair claims, returns, safety and warranty issues, market and customer research, and even social media.[34]

Real-time automation and process integration across the supply chain can help manufacturers respond more quickly to consumer demand.[35] And, with 3D printers, manufacturers can build prototypes or even final products tailored to customer requirements without slowing down production or incurring additional costs.[36]

CURRENT USES
A coffee machine manufacturer can embed a tiny, connected device within its coffee makers to collect information about when consumers turn the machine on and off, how many cups they make in each setting and any ancillary features the customer may use. The device sends this data via wireless internet back to the manufacturer who then can use it to design new features based on a better understanding of how consumers actually use their products.[37]

SUSTAINABILITY

Sustainability in manufacturing is about more than just economics. Minimizing environmental impacts while conserving energy and natural resources is another key item on the manufacturing agenda.[38]

Sensors and data analytics provide the potential for manufacturers to evaluate every aspect of the manufacturing process from a sustainability standpoint. Armed with data, manufacturers can take more informed actions to diminish energy loads and minimize waste.[39]

Lights-out manufacturing, which allows for production with minimal or no human intervention, is a strategy that some manufacturers employ to lower the need for climate control, lighting in unused spaces and to improve energy efficiency.[40] Plants can also automatically turn down lights and adjust factory room temperature when workers leave the factory floor and readjust ambient conditions when they clock in for the next shift.[41]

CURRENT USES
A plastics molding company with manufacturing, warehousing and dispatch facilities switched to a wireless cloud-based lighting control system. The company is now able to continually monitor and regulate lighting usage across its locations, scheduling lights to activate as needed. The result is a marked reduction in energy consumption and cost savings.[42]
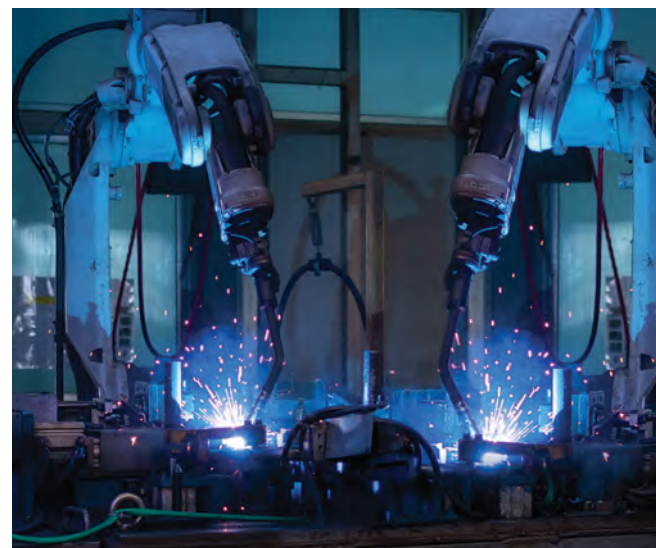
SECURITY

Every manufacturer, regardless of size, faces the challenge of physical plant security. Manufacturers depend on the safe arrival of parts and materials, and protecting production processes from theft, accidents, tampering and unauthorized access.

Security personnel can leverage data from smart sensors, security devices and other information sources to help them monitor the plant for potential security incidents. For manufacturers with multiple sites, remote access technology can be an indispensable tool for loss prevention. Surveillance systems that utilize artificial intelligence can detect people in restricted areas and send alerts.[43]

CURRENT USES

A food manufacturing company has taken steps to upgrade security systems and operations by installing a self-monitoring security system. The system includes sensors to provide real-time data related to door usage, loading dock activities and after-hours production facility surveillance.[44] This helps to ensure only those individuals trained in food safety enter the building.

As manufacturers consider the often game-changing potential technology solutions bring, understanding the risks they introduce beyond traditional exposures can be crucial.

Technology-related risks to manufacturers

Technology presents opportunities for manufacturers to streamline complex processes and increase productivity and profitability. But with the rewards come new challenges. In order to both transform and thrive, manufacturers should understand the inherent risks of integrating technology into their operations.

CYBER

IIoT and other internet-connected sensors and devices that manufacturers bring into their operations can pose a cyber risk. Each gives criminals a possible entry point to exploit, expanding the organization's potential "attack surface." Successful attacks can sabotage production, corrupt data, damage equipment and cause significant financial and reputational harm. Intellectual property may also be stolen.

The manufacturing industry suffered more cyberattacks than any other industry in 2021.[45] It was targeted in over 20% of all worldwide breach attempts, and ransomware was the top attack method, accounting for 23% of attempts.[46] Cybercriminals know that manufacturers are vulnerable to failures in the production and supply chain, which increases the likelihood that their ransom demands will be successful.

The number and cost of cyber threats may continue to grow every year as cybercriminals become increasingly sophisticated, making it essential for manufacturers to protect their digital assets with strong cybersecurity measures.

RISK SCENARIO:
Video vulnerability

Hackers take advantage of a vulnerability in an internet-connected video surveillance system to connect to a manufacturer's network. Once in the network, the hackers obtain the credentials of an administrative user and are able to move freely throughout the system.

They spend months undetected, gathering and exfiltrating as much sensitive company and customer information as possible. Then they encrypt the company's system and data and demand a ransom for the decryption key needed to restore network access.

If the organization does not pay the ransom within two days, the hackers threaten to publish all of the company's sensitive data and customer information on the internet.

WHAT IS RANSOMWARE AND HOW CAN MULTIFACTOR AUTHENTICATION (MFA) HELP?

Ransomware is malicious software that locks up a computer or its data until a ransom is paid. The data held hostage is encrypted, preventing users from accessing it. The victim receives a message from the hacker who demands a payment in exchange for a decryption key that releases the locked data.

Ransomware criminals often gain network access with phishing attempts that implant password-stealing malware or trick users into exposing login credentials.

MFA can minimize the success of these tactics. Users must supply two or more pieces of information when logging in to a network, such as a password plus the correct answer to a security question or a code sent to their mobile phone. Hackers may gain possession of employee passwords, but they're unlikely to have access to the additional factors required to log in. This can greatly reduce the risk of a ransomware attack.[47,48]

CYBER RISK CONCERNS CONTINUE TO RISE

Cyber is the **#1 concern** across all businesses.

BIGGEST CYBER-RELATED BUSINESS CONCERNS:

Security breach/someone hacking · System glitch · Unauthorized access to financial accounts

Over 50% of businesses worry about being a victim of cyber extortion/ransomware.

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WORKPLACE SAFETY

The factory floor has traditionally been labor-intensive, exposing workers to a higher risk of accidents and injuries.[49] As technology changes the way workers engage with the process, hazards are often reduced. Yet, technology also presents new risks, including:

- Exposure to moving machinery and robotic parts.
- Equipment and devices that perform unexpectedly due to programming errors.
- Data errors that create safety-related hazards.
- Lack of training or understanding of machinery safeguards.
- Changes in ergonomics and employee engagement.

BUSINESS INTERRUPTION

Manufacturers can suffer significant downtime if the technology or data they rely on becomes unavailable, whether due to a system problem, cyberattack, natural disaster or other widespread event such as a fire or storm. If the manufacturer is part of a supply chain, multiple companies could be impacted, magnifying the extent of the disruption and financial loss. For manufacturers that have become dependent on automated technologies, returning to manual processes to keep the business going may no longer be an option, leaving them at a loss until digital operations are restored.

**RISK SCENARIO:
Unexpected downtime**

A metals manufacturer experiences a temporary shutdown when a storm causes a water leak that damages the company's welding robot, a single chokepoint in their production process. Without it, operations come to a halt as they wait for delivery of an electronic component from overseas. The result is a lost customer — and significant production delays.

**RISK SCENARIO:
Stamping hazard**

A stamping press is connected to a production line where sensors are used to synchronize the placement of raw metal into the press. The stamping press, conveyor and material-handling robot are made by different manufacturers. The safety software and devices are not fully understood by the system integrator who unknowingly made the system less safe when providing a central control panel. As a result, a maintenance worker who believes that the machinery is fully deenergized is struck by a robotic arm that suddenly activates.

MANUFACTURING DEFECTS

Manufacturing technology often has configurable options designed to monitor and control product quality at critical points in the production process, resulting in fewer product defects and production line mishaps.

However, production can go awry. The introduction of new technology and manufacturing methods can result in unintended product defects. The products could then fail to meet customer expectations, cause property damage, injury or financial loss, which in turn can lead to lawsuits and potentially impact the manufacturer's brand and reputation.

RISK SCENARIO:
Disgruntled and destructive

An employee leaves his company to join a startup competitor. In an effort to increase market share, this individual hacks into his former employer's network and gains access to production line control systems. The employee makes slight changes to sensor tolerances that go undiscovered so that the products do not conform to design specifications. The company begins to lose market share due to the unreliability of its products and reputational damage.

PROPERTY DAMAGE

Manufacturing technology can come with unique risks due to the convergence of automated and physical work. If a digital device is incorrectly integrated into plant operations — due to problems in planning or programming, for example — it could damage the facility, raw materials or finished goods. Control systems for machinery, pressurized processes or temperature-controlled environments might cause overheating, an explosion or product spoilage.

RISK SCENARIO:
Self-guided material-handling robot

An electronics manufacturer uses autonomous material-handling vehicles to deliver parts from staging areas to production cells and move assembled goods to the warehouse. The vehicles are guided by a sensor system that uses guidance beacons to form a map of the production floor. The guidance system software fails, and the vehicle strikes a warehouse rack causing damage to products ready for shipment. As a result, stock is damaged or destroyed and customer orders are delayed.

Actions to consider for minimizing technology risks

As manufacturers continue to harness the power of technology, they may unknowingly expose their companies to significant risks. Should a hacker break into the network or equipment fails to function properly, operations could be compromised and people harmed. Manufacturers should consider these actions to help minimize their exposures.

REINFORCE CYBERSECURITY

Information security is a concern for manufacturers worldwide. Yet, even with the tightest controls, breaches still occur. This can cost manufacturers millions in recovery and liability costs, with reputational damage that can prove insurmountable. The following steps can help reduce the risk of a cyberattack and lessen its impact.

- **Maintain an asset inventory.**
  A complete inventory of all network assets is an important first step to understanding all possible points of network intrusion. Even a network printer can harbor a vulnerability that would allow an attacker to secure administrative privileges or spread malware throughout a network.

- **Conduct a risk assessment.**
  Evaluate the risk associated with each asset identified in the inventory. Identify those assets that store, process or transmit business–critical or sensitive data. Consider the potential impact of a cyber event and identify gaps, such as software patches, that need to be addressed.

- **Segment network traffic.**
  This allows manufacturers to isolate and limit access to sensitive or critical data. If a worker falls for a ransomware trap, this can prevent the virus from spreading throughout the network.

- **Back up data daily.**
  Data backup can be quickly recovered, helping to restore operations in the event of an attack. Frequently back up of all important files and store them offline to prevent hackers from gaining access.

- **Monitor network vulnerability 24/7.**
  Actively scan for unauthorized and unusual network activity and take prompt corrective action. Endpoint detection and response (EDR) is one security solution that continuously monitors all endpoints on a network, from computers and phones to devices and printers. If suspicious activity is detected, the EDR solution will take remedial action before the rest of the network is exposed.

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- **Change default passwords.**
  Companies often overlook the need to change default passwords on sensors and devices. Leaving default passwords in place can provide an easy way for attackers to steal data or to change settings.

- **Use multifactor authentication (MFA).**
  MFA requires users to supply two or more pieces of evidence when logging in to a device or network. This can make identity theft more difficult and stolen credentials less fruitful.

- **Implement patch management.**
  Patches address security vulnerabilities within products and programs. Install patches as soon as possible and provide compensating controls when devices with known vulnerabilities cannot be patched.

- **Secure the cloud.**
  Insist on seeing the cloud provider's written security procedures. If possible, visit the provider's premises to ensure those procedures are being followed.

- **Build for security.**
  Establish a framework of standards, guidelines and practices to reduce the plant's cyber vulnerability. Update it continually to ensure ongoing compliance, and make sure all involved employees are well-educated on their roles.

- **Promote security awareness.**
  To minimize the risk of a cyber exposure, train employees on how to safeguard confidential and sensitive data, avoid phishing attempts and be generally cognizant of all facets of cybersecurity.

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PLAN FOR BUSINESS INTERRUPTIONS

As manufacturers become increasingly connected and data-driven, they face the growing risk of digital disruptions that could threaten their business. Business continuity planning is essential to help manufacturers restore operations quickly if critical technology services fail or system connectivity is interrupted. Developing an effective business continuity plan can include four steps:

1. **Identify risks or threats that leave employees, machinery and operations vulnerable.**
   Risks can include fire, flooding or other natural disasters, power outages, IT or OT system failures, and inadequate safety protocols.

2. **Conduct a business impact analysis.**
   Consider who and what is absolutely necessary to restore critical operations. Identify the people, skills, parts, machines, vendors and programs critical to the survival of your business.

3. **Adopt controls for prevention and mitigation.**
   Measures may include:
   - Having standby machinery and critical replacement parts in place.
   - Identifying backup technology providers and contract manufacturers that can provide parts, assemblies or finished products during the period of restoration.
   - Plans to conduct mission-critical operations in manual or low-tech mode until automated services can be restored.
   - Plans for emergency response, employee communications, resource and facility management, public relations and customer engagement.

4. **Test, exercise and update your plan regularly.**
   Test and update your plan routinely, or any time-critical functions, facilities, suppliers or personnel changes. Train employees on their roles and conduct hypothetical walk-throughs, live drills or simulations. To reinforce the importance of the plan, communicate the ways in which it strengthens plant safety and protects operations.

PROMOTE A CULTURE OF WORKPLACE SAFETY

Technology can help employees work smarter and safer and eliminate many manual tasks that traditionally led to workplace injuries. But technology is only as good as the system it supports, and accidents can still happen. A manufacturer's key role is to ensure that technology is integrated with the employee in mind, and that workers have the skills and knowledge necessary to perform their jobs, manage and operate new technologies, and uphold workplace safety standards and best practices.

These steps can serve as a starting point for creating and maintaining a culture of safety as new technologies are integrated:

- Demonstrate management involvement in a safety culture.
- Communicate safety plans clearly and make them available to all employees.
- Get everyone involved in participating in safety practices.
- Document, train and coach safe work practices.
- Review, revise and continually improve safety programs.
- Investigate incidents and accidents thoroughly to help identify and address the root cause.
- Support your injured employees from the moment of injury through their return to work.
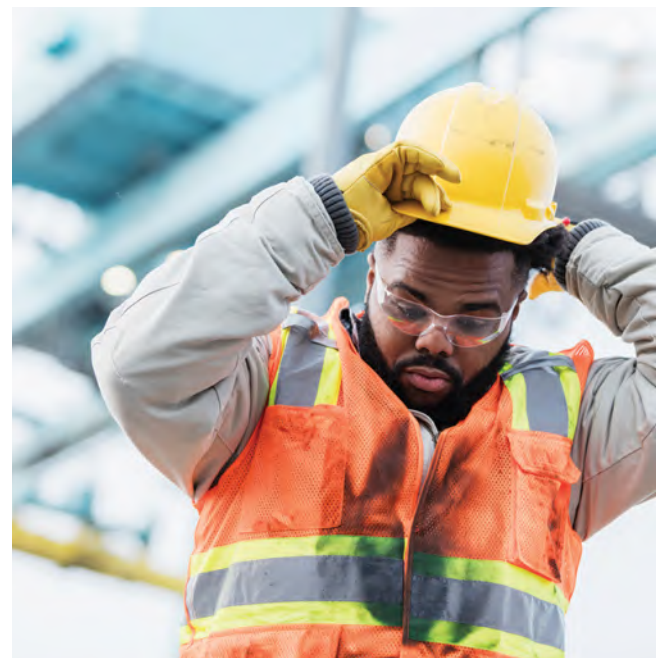
EVALUATE COMPANY CONTRACT PRACTICES

In the modern factory, quality control along the many stages of the production and assembly process is a collaborative effort between humans and technology.[50] In spite of stringent safeguards and quality controls, defective products may be released into the marketplace. If a defective product results in a claim or legal action, a manufacturer's exposure may be mitigated through diligent application of contractual best practices, guided by legal counsel.

These may include:

- **Limitation of liability:**
  This provision disclaims liability for certain types of damages – usually incidental, consequential or special damages. In the event of threatened litigation, these provisions can become very useful.

- **Damage caps:**
  These provisions seek to limit the amount of recoverable damages. The limitations can be defined in terms of a specific dollar amount or an amount to be determined, depending on specific factors set forth in the contract.

- **Disclaimer/limitation of warranties:**
  This provision identifies the warranties provided, disclaims or limits those warranties not provided, and identifies the remedies available in the event the product or work does not comply with the warranties provided.

- **Contractual risk transfer and defense/indemnity provisions:**
  Provisions like these can shift risk to the responsible parties most able to control it.

These and other available opportunities to limit liability should be reviewed by an attorney experienced in contract law.

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Digital transformation: Workforce considerations

Digital transformation opens many doors, but it can also be disruptive in many ways, including to the workforce. Jobs are changing. Some roles are disappearing; others require entirely new skills and knowledge. Managers are grappling with finding, developing and retaining the talent they need. And people have only so much capacity to adapt to change.[51]

Manufacturers may be accelerating their adoption of technology, but too much too soon can upend a business. Having a strategic implementation plan and considering the human side of the equation can be essential to help ensure that workers can adjust, risks remain manageable and new technologies are used successfully.

BUILD A TECHNOLOGY ROAD MAP

Before introducing new technology, begin by assessing:

- Your company's current state.
- Goals and priorities.
- The changing nature of employee engagement and safety.

Informed by that big-picture view, solve for one technology opportunity at a time to improve the chances of successful implementation:

- Focus on a high-priority area that's impactful, manageable and realistic.
- Understand how employees will interact with the technology. Anticipate the risks of a particular technology and be proactive about mitigating them.
- Train employees before introducing change. Explain the value and role of the new technology and how it will change employee responsibilities and manufacturing processes.
- Monitor deployment. Get employee feedback, review data analytics and verify that the technology is delivering real benefits.
- Retool and refresh accordingly.

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PLAN FOR THE FUTURE OF WORK

According to a recent study conducted by The Manufacturing Institute and Deloitte, the U.S. manufacturing skills gap could result in 2.1 million unfilled jobs by 2030.[52] Manufacturers surveyed in the study reported finding the right talent was nearly 40% more difficult in 2021 than it was in 2018.[53] More than 75% forecasted having ongoing difficulties in attracting and retaining future workers.[54]

These findings are compounded by the "silver tsunami" of 2.6 million baby boomers expected to retire from manufacturing in less than 10 years and the lack of young people entering the manufacturing workforce.[55]

As manufacturers seek to overcome talent shortfalls and create a demand for jobs, they can take these actions to address labor shortages and skills gaps:

- Engage with existing workers to gauge job satisfaction and opportunities to build a workforce culture for the long term, including acting on diversity in meaningful ways.

- Broaden the talent pipeline through reskilling programs for new and existing employees. Evaluate likely candidates based on the new skills required rather than the parameters of their previous job.

- Consider adapting the workplace to meet the needs of multiple generations at work, including providing flexible work options, increased health and well–being support and clear avenues for job progression.

- Build excitement in the next generation of manufacturing careers through partnerships with local schools and colleges.

- Consider tapping into organizations such as AARP to garner the interest of older adults who may be seeking career changes or returning to work following retirement.

- Leverage the additional upsides of modernizing your factory, including the ability to attract skilled talent with an interest in technology.

Technology will continue to reinvent the role of the manufacturing professional. People and machines can work in harmony when companies effectively prepare.

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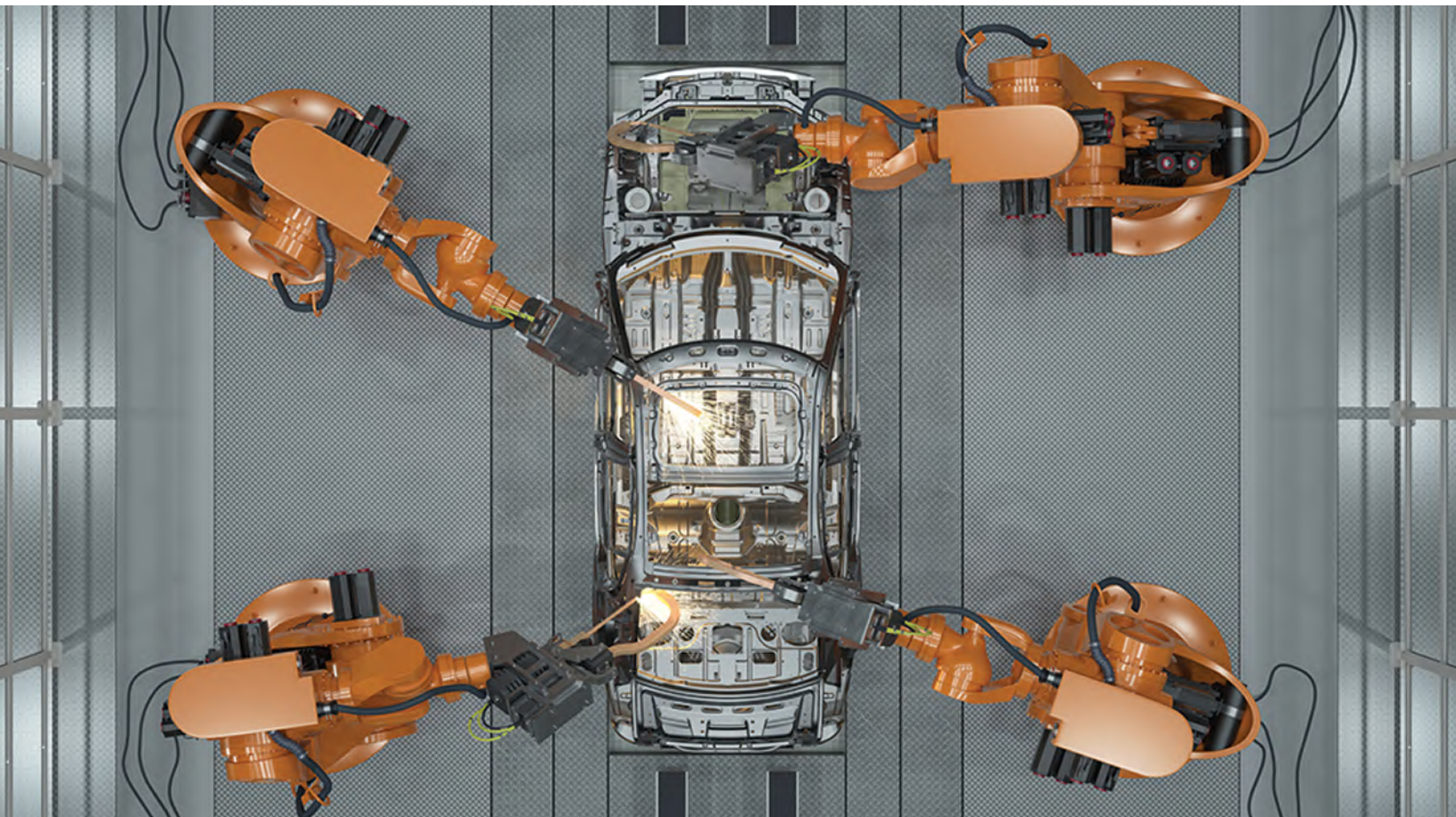
BUILDING AND MAINTAINING A CULTURE OF WORKPLACE SAFETY

Constructing and retaining a culture of workplace safety continues to be a guiding principle in the digital factory. Technology solutions improve safety in many ways, but they also carry novel risks. New exposures posed by modern technology can cause cumulative trauma. For example, workers may be injured by an interaction with an autonomous robot as it moves across the factory floor.

Identifying and planning for the safety hazards each technology might introduce can reduce or prevent injuries.

At a minimum, this includes:

- A thorough risk assessment and proper installation of the technology.
- Requiring workers to wear necessary personal protective equipment.
- Prioritizing ongoing employee training with an emphasis on safe work practices and employee feedback.

Safe manufacturing practices have the potential to decrease absenteeism, boost productivity and increase quality and morale. And, a structured onboarding and training process can help orient employees to your organization's culture of safety.

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New workers, new risk

Despite the safety improvements technology affords, accidents and injuries continue to occur in the manufacturing environment. These injuries may:

- Put the health of employees at risk.
- Lead to lost time in the workplace.
- Impact the company operationally and financially by reducing productivity and increasing workers compensation claims.

Travelers regularly analyzes workers compensation claims to detect loss trends. Insights like these can help manufacturers identify where additional training programs and safety practices may be needed to help protect against common workplace injuries.

According to our claim data:[56]

- Employees in the manufacturing industry *missed an average of 64 days of work due to an injury*.
- Workers who had been in their role for less than one year before being injured made up *28% of all manufacturing claims*.
- Experienced employees and those operating more complex machinery were injured less frequently but had costlier claims. During the five-year period that was analyzed, employees with *25 or more years of experience represented the smallest percentage of claims*.

Injury prevalence in manufacturing, particularly with new employees, underscores the importance of effectively preparing employees to thrive in a technology-centric environment. It also emphasizes the need for manufacturers to promote job practices that reduce turnover. This includes taking steps to improve job security, career growth and employee loyalty.
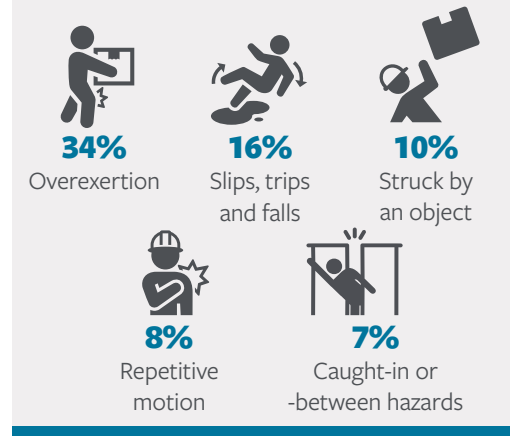
These efforts can help to reduce the risk of injury prevalence, thereby reducing workers compensation claim frequency and cost.

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Employee Injury Trends in **MANUFACTURING**

The average cost of an injury in manufacturing has **increased by approximately 17%** over the past five years.

Top five most frequent causes of injury:

34% Overexertion

16% Slips, trips and falls

10% Struck by an object

8% Repetitive motion

7% Caught-in or -between hazards

The top five most frequent causes of injury **made up 80% of all incurred costs**. Of those, slips, trips and falls were the most severe.

Top five most common resulting injuries:

37%	Strains and sprains
12%	Fractures
9%	Inflammation
7%	Dislocations
6%	Contusions
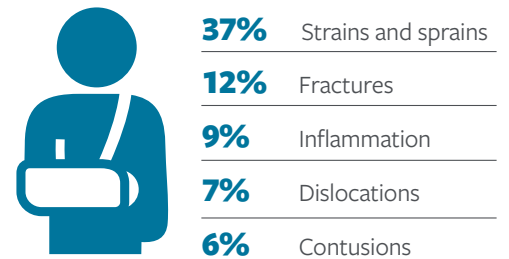
28% of all manufacturing injuries **came from first-year employees**.

Insurance considerations for manufacturing technology

As they adopt new technologies, manufacturers face special challenges that may present new or unexpected risks. Many production lines were designed decades ago, long before the technological developments that have led to Industry 4.0, so the net effect of these devices from one implementation to the next is uncertain.

Safety features, data protection measures, effective risk management and good design decisions can help manufacturers benefit from technological modernization while reducing their exposure to some of the risks we see today. Yet every emerging technology has the potential for unanticipated risks. To prepare, companies should consider their insurance options for mitigating the categories of risk described in this white paper.

RISK TYPE	RELEVANT INSURANCE COVERAGE TO EVALUATE WITH AN AGENT
Cyber	**Cyber coverage** provides coverage for critical cyber risks. Coverage options vary, but most include privacy and security liability, media liability and regulatory proceedings coverage. Firms can also opt for many first-party coverages, including forensics, data restoration, business interruption, computer fraud, funds transfer fraud, cyber extortion, crisis management expenses and security breach notification expenses.
Product liability	**Product liability coverage** provides coverage to help cover the costs of claims that your company is responsible for because of physical harm to a person or property caused by a defective product manufactured, sold, handled, distributed or disposed of by your business.
Manufacturing errors & omissions	**Errors & omissions (E&O) liability coverage** helps cover the costs of financial damages manufacturers must pay when products fail to perform the function or serve the purpose intended, due to an error, omission or negligent act.
Management liability	**Management liability** provides coverage to help protect the business, its board of directors and other covered parties from the costs related to claims brought by employees, as well as by third parties. These include employment practices, directors and officers and fiduciary (ERISA) liability claims.
Product recall	**Product recall coverage** can help cover certain expenses, including crisis management services, incurred in connection with the removal of your product from the marketplace because it is deemed potentially harmful to people or property
Property and equipment breakdown	**Property insurance** provides coverage for buildings, business personal property, and loss of business income and extra expense. Equipment breakdown insurance helps pay for costs to repair or replace damaged machinery or malfunctioning equipment.
Workplace safety	**Workers compensation coverage** can help protect manufacturers and their employees from the associated costs after a work-related injury or disease. For the injured employee, workers compensation helps cover the costs of medical care, lost wages and other statutory benefits. For the employer, workers compensation typically provides a sole remedy, avoiding expensive civil litigation, plus peace of mind knowing employees will get the help they need to recover and return to work.
Large losses	**Umbrella and excess casualty coverages** can provide an extra layer of protection above the limits of a manufacturer's primary insurance policy, helping to limit exposure caused by large claims.

How Travelers can help

As manufacturers adopt new technologies, they face special challenges that may present unanticipated risks. Wherever you are in your digital transformation journey, insurance can help protect your business from new and emerging technological risks. Travelers has deep risk expertise and extensive experience with the manufacturing industry. You can get specialized insurance solutions and risk management services designed precisely to help manage your company's unique risks.

For more information, contact your independent Travelers insurance agent or visit us at **travelers.com/manufacturing.**

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Endnotes

1 https://www2.deloitte.com/us/en/insights/focus/industry-4-0/digital-lean-manufacturing.html

2 https://www.thomasnet.com/articles/top-suppliers/advanced-manufacturing-companies/

3 https://www.mdpi.com/2227-9717/10/3/539/htm

4 https://www2.deloitte.com/us/en/insights/focus/technology-and-the-future-of-work/tech-leaders-reimagining-work-workforce-workplace.html

5 https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution

6 https://www.cio.com/article/228901/what-is-predictive-analytics-transforming-data-into-future-insights.html

7 https://www.travelers.com/iw-documents/business-insurance/tech-3D-whitepaper-BTCWH.0003-D.pdf

8 https://www.business.com/articles/virtual-reality-changing-manufacturing/

9 https://www.i-scoop.eu/industry-4-0/

10 https://www.themanufacturer.com/articles/using-technology-improve-manufacturing-processes/

11 2021–2022 Travelers data; total number of manufacturers surveyed: 2,536; small: 299; medium: 1,254; large: 983

12 2021–2022 Travelers data; total number of manufacturers surveyed: 2,536; small: 299; medium: 1,254; large: 983

13 2021–2022 Travelers data; total number of manufacturers surveyed: 2,536; small: 299; medium: 1,254; large: 983

14 https://www.forbes.com/sites/bernardmarr/2022/01/25/the-10-biggest-future-trends-in-manufacturing/?sh=7c51bbfc4d56

15 https://world-class-manufacturing.com/tpm/pm.html

16 https://www.metcal.com/hand-soldering/solutions-for-soldering-military-grade-high-thermal-mass-radio-frequency-rf-printed-circuit-board-assemblies-pcba/

17 https://www2.deloitte.com/us/en/pages/operations/articles/smart-sensors-and-supply-chain.html

18 https://internetofbusiness.com/8-real-life-examples-iot-supply-chain/

19 https://www.wuerth-industrie.com/web/en/wuerthindustrie/cteile_management/kanban/kanban_steuerung/ibin_intelligenterbehaelter/ibin.php

20 https://www.atriainnovation.com/en/sensors-for-production-lines/

21 https://www.powerelectronicsnews.com/why-do-you-need-robots-in-quality-control/

22 https://www.sciencedirect.com/science/article/pii/S2667241321000057

23 https://www.industryweek.com/operations/article/21120473/machine-vision-promises-nearly-flawless-quality-control

24 https://atos.net/en/industries/inside-smart-factory-white-paper

25 https://sameerdhanrajani.wordpress.com/2016/06/13/sameer-dhanrajani-smart-manufacturing-enabled-by-data-sciences/

26 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7731246/

27 https://www.accenture.com/us-en/~/media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Industries_8/Accenture-Marathon-Teaming-Protect-Employees.pdf

28 https://ecorobotics.com/industrial/6-ways-robots-can-be-used-to-address-unsafe-working-conditions/

29 https://www.getac.com/us/blog/safety-technologies-for-heavy-industries/

30 https://www.accenture.com/us-en/~/media/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Industries_8/Accenture-Marathon-Teaming-Protect-Employees.pdf

31 https://www.prweb.com/releases/2012/2/prweb9193151.htm

32 https://www.mdpi.com/2227-9717/10/3/539/htm

33 https://hbr.org/2016/09/building-an-insights-engine

34 https://www.sas.com/content/dam/SAS/en_us/doc/analystreport/aberdeen-marketing-analytics-for-manufacturing-106822.pdf

35 https://www.automationmag.com/8062-automating-real-time-demand-driven-supply-chains/

36 https://www.travelers.com/iw-documents/business-insurance/tech-3D-whitepaper-BTCWH.0003-D.pdf

37 https://www.wsj.com/articles/keurig-dr-peppers-data-tracking-helps-in-making-financial-forecasts-11596753392

38 https://www.epa.gov/sustainability/sustainable-manufacturing#:~:text=Sustainable%20manufacturing%20is%20the%20creation,employee%2C%20community%20and%20product%20safety

39 https://www.forbes.com/sites/forbestechcouncil/2022/05/20/sustainability-in-the-manufacturing-industry-is-a-work-in-process/?sh=7d212dd2310e

40 https://robotsdoneright.com/Articles/lights-out-manufacturing-for-sustainable-operations.html#:~:text=Lights%2Dout%20manufacturing%20has%20many,creates%20a%20sustainable%20manufacturing%20process

41 https://robotsdoneright.com/Articles/lights-out-manufacturing-for-sustainable-operations.html#:~:text=Lights%2Dout%20manufacturing%20has%20many,creates%20a%20sustainable%20manufacturing%20process

42 https://www.inddist.com/home/article/13772864/case-study-shedding-light-on-energy-efficient-warehouse-lighting

43 https://www.forbes.com/sites/forbestechcouncil/2020/12/04/how-ai-is-making-an-impact-on-the-surveillance-world/?sh=37bb334d265e

44 https://www.processingmagazine.com/maintenance-safety/article/21222723/tightening-physical-security-at-food-processing-plants

45 https://www.ibm.com/security/data-breach/threat-intelligence/

46 https://www.ibm.com/security/data-breach/threat-intelligence/

47 https://www.microsoft.com/security/blog/2019/08/20/one-simple-action-you-can-take-to-prevent-99-9-percent-of-account-attacks/

48 https://www.travelers.com/resources/risk-index/2021-cyber-infographic#:~:text=Here's%20a%20look%20at%20key,the%20top%20cyber%2Dspecific%20concerns.&text=Cyber%20is%20the%20%231%20concern%20across%20all%20businesses.&text=The%20number%20of%20businesses%20reporting,cyber%20event%20continues%20to%20increase

49 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7589804/

50 https://deltaregis.com/2020/11/16/why-assembly-lines-still-need-humans-in-the-wake-of-robots/

51 https://www.gartner.com/smarterwithgartner/lack-of-skills-threatens-digital-transformation

52 https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html

53 https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html

54 https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html

55 https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-skills-gap-study.html

56 All data, including in the infographic depicting employee injury trends in manufacturing, is Travelers Indemnity claim data, in accident years 2015–2019. Zero-dollar claims excluded. Valued Dec. 31, 2020. Losses are unlimited and undeveloped. Unless otherwise noted, data points represent claims across all employees in the manufacturing industry

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