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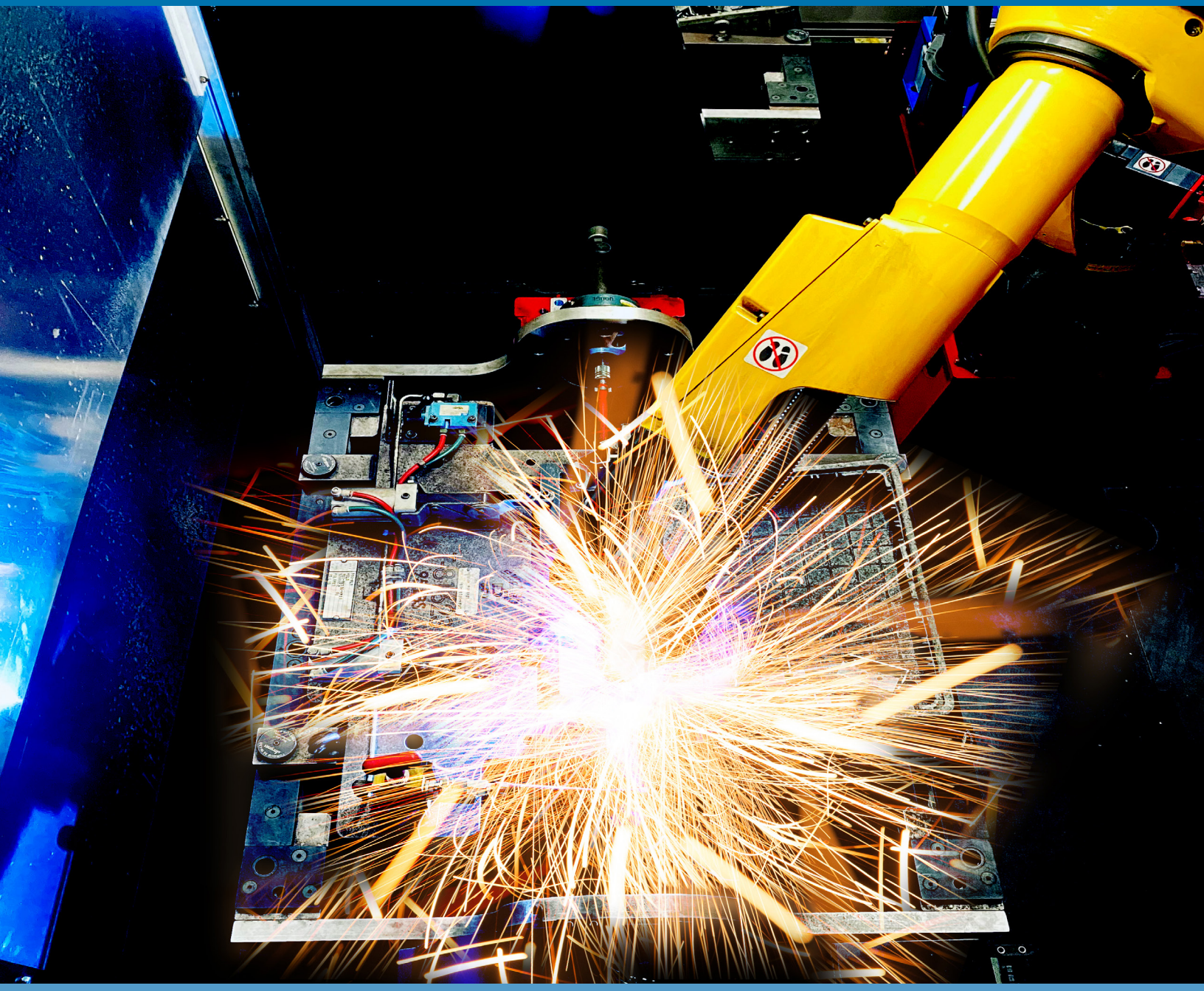

Manufacturers' Guide to Industry 4.0 Technologies

The go-to resource for small and medium-sized manufacturers

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Thank you to the experts across the MEP National Network whose work inspired this document.

Introduction

Why don't small and medium-sized manufacturers (SMMs) adopt new technologies more quickly? Studies have uncovered many reasons, but most boil down to a very simple barrier: the lack of time.

Resources are tight and immediate business needs take precedence. You have orders to fill, employees to hire and train, payroll, supply chain disruptions, maintenance and more. Your smaller shop doesn't have the budget of an original equipment manufacturer. You can't hire and train more employees as easily as a large operation.

On the flip side, SMMs have fewer layers. You can get input, develop a business case and make decisions faster than a large shop. Smaller manufacturers also don't have as many information technology layers to deal with when implementing new technology.

This guide is for SMMs that don't have time to sort through overwhelming amounts of information about Industry 4.0 technologies. We hope to provide answers to some of your questions and concerns, so you can begin adopting technologies that make sense for your company.

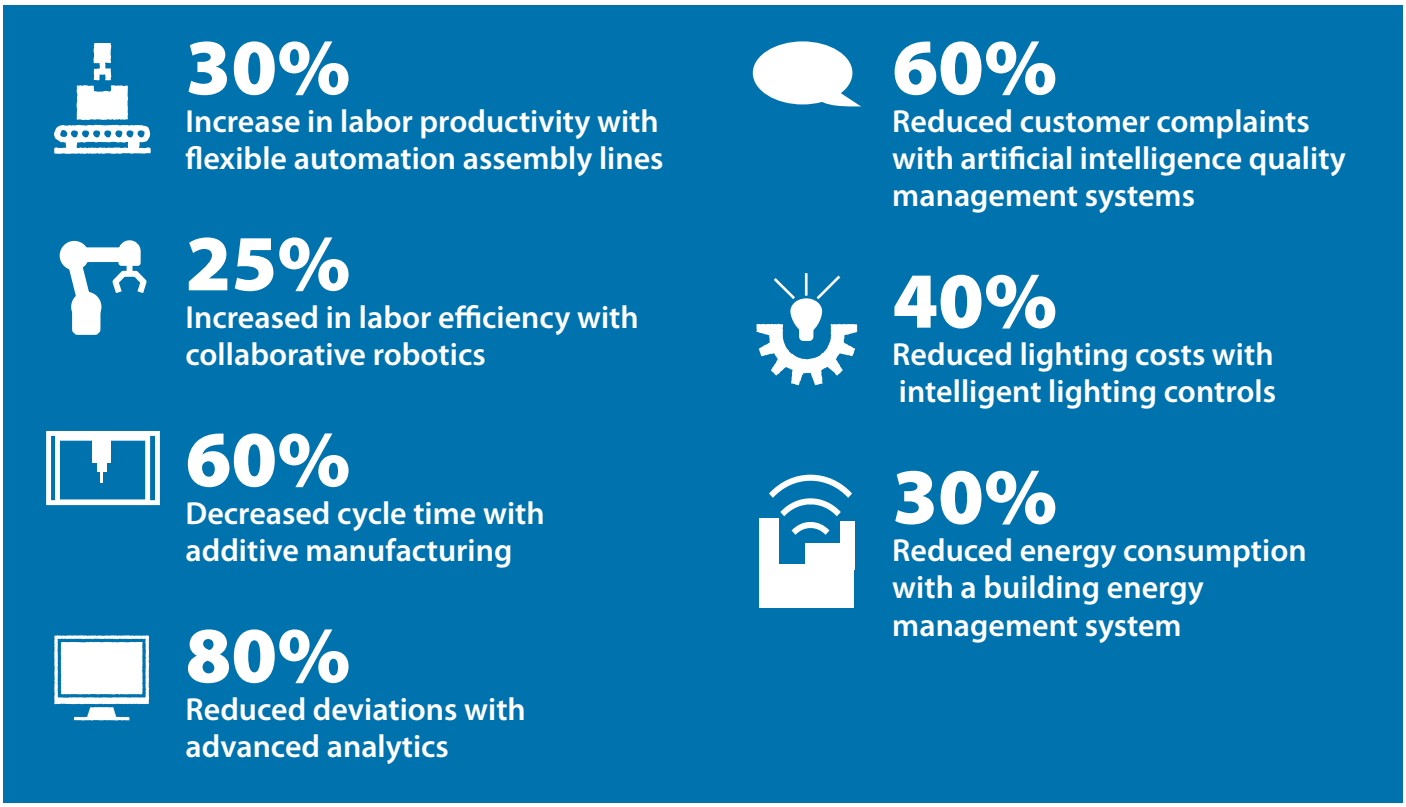
This guide includes unbiased information about technologies that are helping other SMMs. You'll learn how to assess technologies so you can determine if they're a good fit for your business. Will the technologies you're considering work in terms of cost and what they can do to help you meet your business needs? This guide will help you decide.

The good news is that technology adoption isn't all or nothing. There are low cost, easy-to-implement technologies that can drastically increase your productivity.

With these, you can dip your toe into the world of Industry 4.0 and experience some of the benefits without major risks.

Achieve meaningful business results with Industry 4.0 technologies

The World Economic Forum's report "Fourth Industrial Revolution: Beacons of Technology and Innovation in Manufacturing" (WEF report, link opens PDF) cites truly meaningful business results that manufacturers achieve with new technologies. These include:



Using technology to combat employee shortages

Employee recruitment and retention is nearly every manufacturer's top challenge. There just aren't enough people to meet current needs between resignations, retirements and fewer young people interested in manufacturing careers.

Workforce challenges impact your company's bottom line. Recognizing this, some manufacturers are stepping up their workforce development programs to implement targeted, scalable solutions. Industry 4.0 technologies can be part of those scalable solutions.

In addition to increased productivity, efficient operations, sustainability, and product innovation, Industry 4.0 technologies can lead to beneficial changes for the existing and future workforce. In fact, adding more technology to the production floor often leads to these two workforce improvements:

- **Upskilling current employees.** Current employees will need additional training to fully maximize the potential and return on investment (ROI) of the new technology. Employers must first know existing proficiencies of their current workforce in order to develop the new competencies required.
- **Attracting new talent.** New and emerging technology in the manufacturing industry will help attract the next-generation workforce that is very comfortable with using technology and data. Technology can be the key to reinvigorating the manufacturing workforce, attracting and nurturing a younger talent pool that previously may not have considered a career in manufacturing.

How to Approach Industry 4.0

Before investing in a technology, you should consider how it will solve a relevant business problem and support your company's goals. This will help you achieve long-term, positive results. To begin, you must understand the current state of your business systems. In this context, a system refers to all the actions and processes involved in running your plant, from data acquisition to operational efficiencies. The success of any technology adoption largely depends on the strength of the systems. If all moving parts communicate effectively and clearly, it will be much easier to integrate new technology into the overall system.

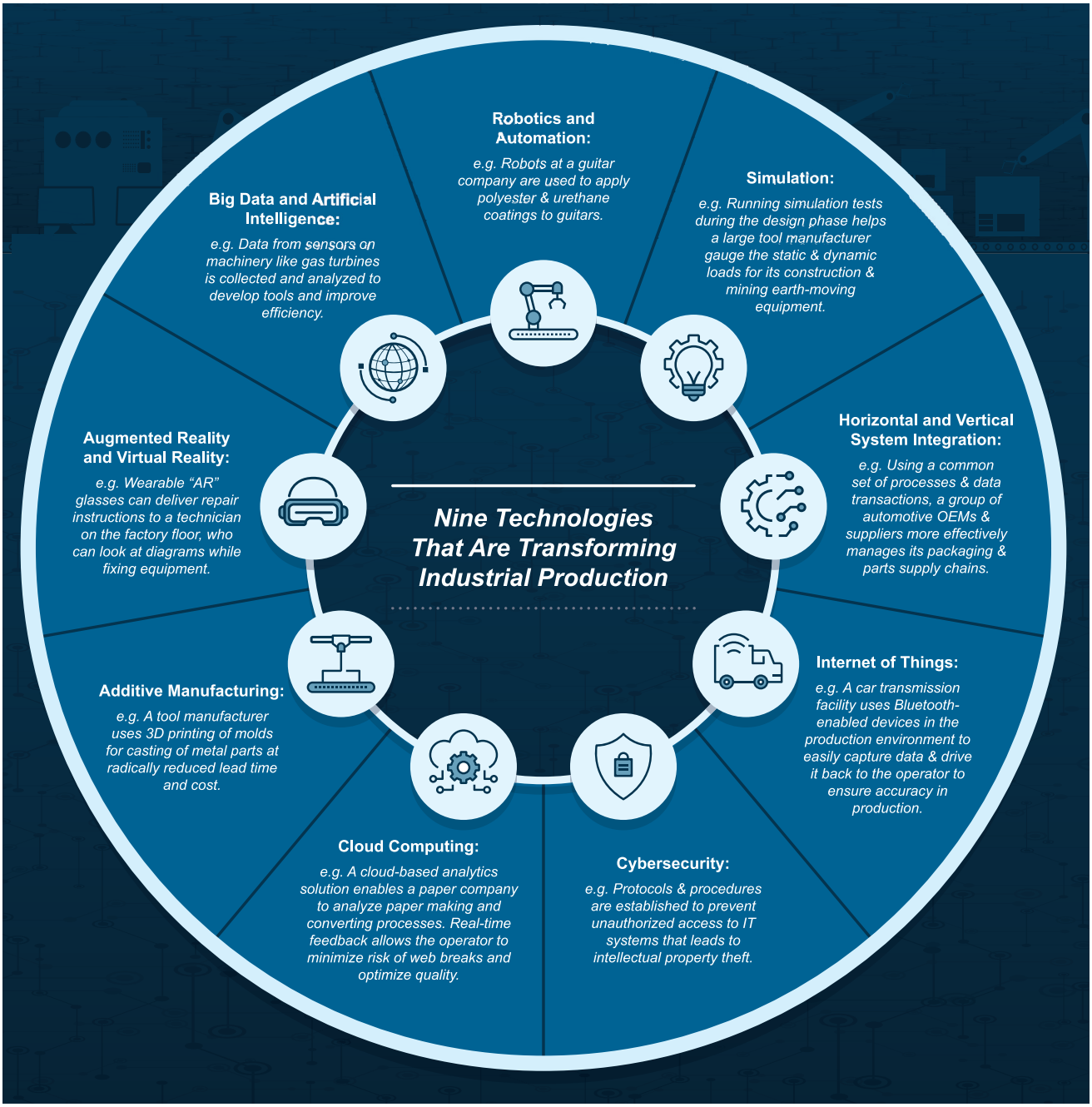
Even if your company is not ready to take a full plunge into Industry 4.0, you can test the waters. SMMs can take many actions to begin capitalizing on the processes and capabilities available. Here's where you can start:

- **Assess the current state of your operations.** Before you dive into a particular technology you should take time to examine the challenges that currently exist in your operations. Focus on your ongoing pain points. Do you have a lot of rework? Too much unscheduled downtime? Or perhaps you are struggling to predict future demand? By identifying your toughest challenges and prioritizing their importance, you can begin to develop objectives and a plan to adopt technologies that are right for your business.
- **Understand and prioritize your business needs.** No company of any size should invest until they are sure that the investment will align with their business needs. Your company's various departments should also agree on priorities. It's critical that you understand your company's key performance indicators (KPIs) and that you tie performance to financial results to track their ROI. For example, will the increased capacity from reducing downtime pay for sensors or condition-based maintenance? Figuring this out could help identify the funding required for further improvements.
- **Learn about and try out available opportunities.** Once you identify opportunity areas, you will want to identify which technologies are available. There are many groups building Industry 4.0 environments where you can get hands-on experience. Conferences and networking groups also bring technology suppliers and customers together. This way you can learn what's available, while providing valuable information to suppliers on gaps and what still needs to be developed.
- **Set goals.** Simply acquiring a new technology isn't enough – it has to be implemented intentionally. This means using it to achieve a desired outcome. It means attending to all of the implications of implementing the technology – from process modifications to changes in company culture. The truth is, most Industry 4.0 technologies align with business goals that you may already have, such as:
  - Optimizing processes
  - Shortening cycle times
  - Improving quality
  - Reducing energy losses
  - Shortening downtimes
  - Improving overall equipment effectiveness

- **Build the blueprint.** Creating an implementation roadmap to achieve the future state is next. The order of technology implementation should be driven by your business needs matched with the ROI. In that context, the suitability of the available products and the processes required to implement them should be considered. Before implementing new technologies, you might need to take preparatory steps. For example, you might wish to use cloud-based data storage to connect with your suppliers and customers. To prepare, you'll need to consider cybersecurity needs before moving to the cloud.
- **Use your current equipment.** Not every Industry 4.0 technology requires you to ditch your existing equipment. Some older equipment can be integrated into an Industry 4.0 environment. For example, you can outfit your current equipment with affordable, after-market smart sensors to improve processes. Then you can reap some benefits of Industry 4.0 technology without purchasing entirely new systems.
- **Start small.** Starting small can be a matter of collecting and interpreting data that is already available. This often proves its value immediately and can eliminate much of the employee apprehension and skepticism. Also, choosing to implement Industry 4.0 technologies in stages makes perfect sense for SMMs. The savings from your early efforts can fund the next ones. As each success adds to your bottom line, the struggle to identify resources for the next opportunity is simplified. As with any continuous improvement effort, an important benefit of this approach is building momentum.
- **Build on success and gain buy in.** Nothing succeeds like success! Give yourself a chance by starting small and focusing on one business need at a time. Identifying and implementing process improvements to drive better business results is hardly a new idea. Of course, a bit of cynicism that each new initiative is simply the flavor of the month isn't new either. If you want your team to embrace change, you'll need to demonstrate the benefits and mitigate the fear of the unknown. Incremental changes help with this, as they're easier to measure, control – and communicate.

Getting to Know 9 Industry 4.0 Technologies

Here's a summary of nine popular Industry 4.0 technologies and how they're helping SMMs improve business operations and achieve positive results.



Augmented reality and virtual reality

Augmented reality (AR) and virtual reality (VR) technologies create new ways of seeing and monitoring the plant floor. What's the difference between AR and VR?

- AR **superimposes computer-generated images onto your view** of the world. You still see your surroundings, but extra information is incorporated into the real environment.
- VR **completely immerses** you in three-dimensional simulated environments that you can interact with in a seemingly real way. VR uses special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.

How AR and VR can help small manufacturers:

Providing comprehensive, immersive training applications.
With VR and AR technologies, you can train employees to a standard of performance, quality and safety. The training can be repeated precisely, without change over time. This minimizes resource usage and results are tracked automatically. Using AR and VR can ensure your employees are properly trained to the same standard, easing knowledge transfer between employees. AR and VR also provide opportunities to practice different production scenarios that might arise so team members know how to handle a variety of challenges.

Guiding workers through repair and operating processes.
Companies can use AR and VR to regularly service equipment, without a training manual or parts catalog. With all information overlaid onto the machine through a simulation, workers can more easily and efficiently complete step-by-step instructions to repair, start up or shut down equipment. This can lower costs for manufacturers that invest excessive time into repairing equipment.

Big data and artificial intelligence

Manufacturing facilities create an endless amount of data each day. Yet many manufacturers don't know how to collect or use it. Big data refers to large data sets gathered from a range of business areas. Manufacturers can use big data to reveal patterns and trends in operations, especially relating to human behavior and interaction. In short, big data can help you make more informed, educated business decisions.

Big data and artificial intelligence (AI) are connected. Big data is what enables AI's decision making. AI uses data from sensors, machines and people and then processes the information to makes decisions without human intervention in a fraction of the time. The decisions made through the speed of AI can have significant impacts on production quality, capacity and waste.

How big data can help small manufacturers:

Monitoring product quality and operations.
Big data provides insight into every step of production. Through sensors attached to equipment, workers can see and respond to disruptions quickly – or even predict and prevent them. This ensures production runs efficiently and accurately. Increased awareness helps lower defects and unplanned machine downtime and it improves product quality. AI can further optimize processes since it analyzes data much quicker and more thoroughly. It also removes inconsistencies of human judgement about adjustments that need to be made.

Driving continuous improvement.
When gathering and analyzing supply chain data, weak spots quickly become apparent. With real-time data, your workers can quickly make changes that improve efficiency and quality – ultimately lowering defects and increasing profitability. Big data can drive strategic business decisions, providing a path forward to successful change.

Enabling demand forecasting.
Manufacturers can look back at historical data to identify trends in customer behavior and predict future demand. This helps manufacturers reduce stock levels and avoid shortages.

Robotics and automation

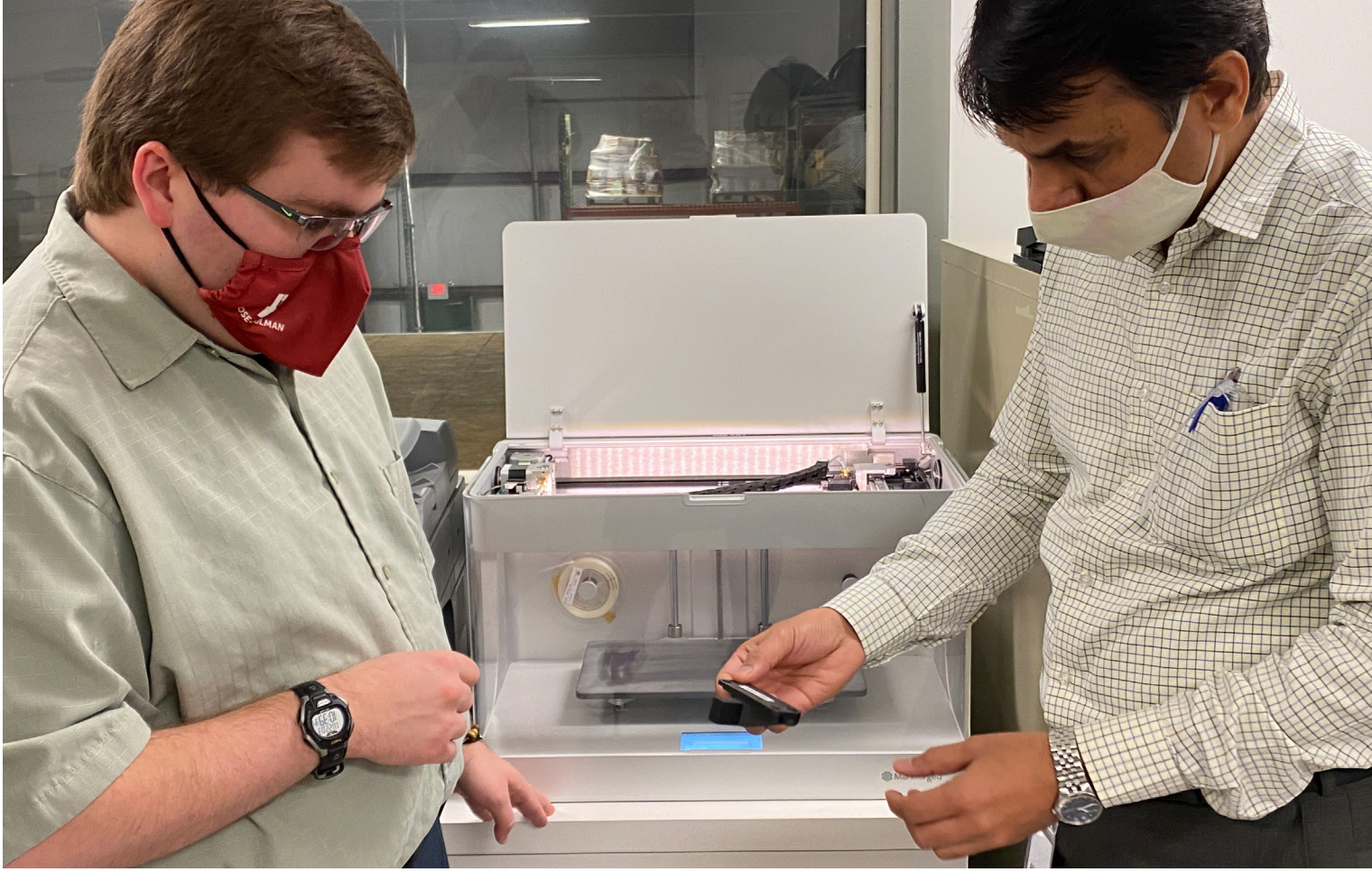
In the increasingly competitive business landscape, manufacturers constantly look for ways to improve processes and boost their bottom line. Implementing robotics and automation in production enables many manufacturers to accomplish this goal. Using machines, robots and control systems to automate repetitive tasks makes your employees' jobs easier. Combining high quality results with employee engagement and cost savings makes automation an increasingly essential innovation, leading more manufacturers to build "smart" factories.

How robotics and automation can help small manufacturers:

Improving efficiency and eliminating variation.
Robotics and automation effectively eliminate variation in production and help reduce the time needed to complete tasks. With human error and variation removed from certain parts of production, quality and efficiency will boom. These improvements translate into huge cost savings for manufacturers.

Increasing safety.
Many manufacturing environments involve potential safety issues for workers such as dangerous machinery, heavy lifting or toxic chemicals. Robots placed in these positions remove the risk of human error, increasing quality and safety – and enabling employees to move into safer roles.

Allowing for greater employee development.
Removing your workers from harmful environments enables them to take on new, more advanced tasks. Automating simple, manual tasks frees your employees for other positions – helping alleviate the current talent shortage in manufacturing. At the same time, automation supports your employee retention efforts. By providing workers with skills training and growth opportunities you'll increase their engagement and loyalty to your organization.



Additive manufacturing

Additive manufacturing, also known as 3D printing, is the practice of adding layers of material (such as plastic, metal, concrete or wood) on top of each other to create a product. Due to its many applications – rapid prototyping, repairs, waste reduction, flexible innovation – additive manufacturing has grown quickly in popularity.

How additive manufacturing can help small manufacturers:

Providing tooling opportunities.
With 3D printing, manufacturers create tools that would be impossible or too expensive to make with traditional methods. Because of the layering process, 3D-printed parts can be stronger, more durable and higher quality overall. Additive manufacturing also minimizes waste. Additive uses only the material needed, without the excess material removed in traditional, subtractive manufacturing.

Allowing for quicker repairs.
The speed and flexibility of additive manufacturing allow manufacturers to efficiently replace old or broken machinery parts. Rather than going to an outside distributor for repairs, all parts can be created in house for quicker and easier replacements. This flexibility also enables you to add to existing parts to extend their life or create new use cases.

Improving the prototype process.
In the past, long lead times for prototyping held many manufacturers back from investing in innovation. With 3D printing, that's no longer the case – you can test a design's functionality without waiting weeks for it to be produced using traditional methods. Most 3D printers can print parts in just hours, rather than weeks or months. 3D printing enables greater flexibility and production innovation, as you can efficiently test new products and make changes before committing to a design.

Simulation

Production processes and part designs can always be improved. Manufacturers face the challenge of figuring out what to change to get the best results. Simulation software assists with this process. Using simulations, you can create virtual representations of a part or process. You can then validate improvement ideas without incurring a huge expense up front – and without impacting current production.

How simulation can help small manufacturers:

Making improvements in the facility, without moving heavy machinery.
With simulation, you don't have to move heavy equipment or disrupt production. Instead, with simulation software you can virtually test out different facility layouts to determine which is optimal. Real-world conditions can also be tested. You can simulate possible production situations and analyze how they would unfold.

Enhancing overall production effectiveness.
Once you've reorganized equipment according to the simulation to optimize processes, you'll quickly notice improvements in lead times, productivity and waste. These advancements would otherwise have taken much more time and expense – or been impossible without the help of simulation.

Testing new parts before making investments.
Similar to 3D printing, simulation allows you to develop and perfect designs for new parts before investing. This results in cost savings, and provides higher confidence and quality in designs.

System integration

Gathering and analyzing data is easier than ever. System integration involves business management software like enterprise resource planning (ERP) systems. An ERP enables you to collect, store, manage and understand data from a variety of areas in your business. This centralized location for your organization's data makes for more efficient data management and increased transparency into business operations. System integration delivers information to those who need it, where and when they need it.

How system integration can help small manufacturers:

Providing one centralized location for data collection.

Many manufacturers don't collect data at all. Or they collect it, but aren't sure how to use it. System integration solves these issues by providing a unified source of data, enabling you to see all your collected data in one place. From there, data can more easily be compared and analyzed to inform strategic decision making.

Improving visibility into the company's planning, scheduling and performance.

Data collection and broad company strategy are often forgotten in the busy day-to-day manufacturing environment. With system integration, you can quickly receive information from all levels of business operations. This helps you maintain a proper balance between daily management and driving future initiatives. Companywide data automatically gathered and presented by the software empowers you to identify areas to improve and set realistic goals for future performance.

Cloud computing

Trying to find the right piece of information when you need it can be like finding a needle in a haystack. This can have serious consequences for manufacturers – putting quality, safety or productivity in jeopardy. Cloud computing eliminates these risks.

Cloud computing involves storing and accessing data and software applications through internet connectivity. This provides a faster, safer and more efficient way to locate company information. With all data in one convenient place, you can find exactly what you need, when you need it.

How cloud computing can help small manufacturers:

Allowing for quicker, easier access to information.
Companies that transfer all data storage to the cloud can instantly access any type of information, whenever it's needed. With data in one digital location, employees can easily find what they need without sorting through endless physical records. Speeding up this process enables your workers to spend more time focusing on larger business goals.

Empowering greater collaboration.
Cloud-based data storage greatly increases your ability to collaborate. Workers in different locations or departments can more easily collaborate when they're all using a single cloud-based data center.

Internet of Things

Internet of Things (IoT) involves using sensors and communications technology to collect and share data that can improve operations. With increased interconnectivity, your company can monitor real-time performance to create an environment of complete visibility and productivity.

How IoT can help small manufacturers:

Providing real-time visibility into operations.
How effective are your processes? When is your next machine going to break down? Where are most defects coming from? These questions and more can be answered with IoT. Sensors in your facility can communicate key information about your operations directly to workers, in the moment. Sensor data gives you greater insight into various production elements. It enables you to predict machine breakdowns, locate bottlenecks and identify production areas that can be improved.

Optimizing performance.
This insightful data enables you to respond to production issues, minimizing or avoiding negative impacts. Preventive maintenance becomes predictive maintenance, allowing for scheduled downtime to maximize production. Your organization can achieve new levels of productivity with tools that help you use resources more efficiently, improve workplace safety and optimize production quality.

Cybersecurity

Unfortunately, the risk of cyberattack rises with increased interconnectivity. Electronic data collection, storage and transmission increase these risks. As companies adopt Industry 4.0 technologies, more are targeted for cybertheft, damage or disruption. The importance of cybersecurity cannot be ignored.

Cybersecurity includes all measures to protect a company from the unauthorized use of electronic data. By safeguarding all hardware, software and information from internal and external threats, manufacturers can stay protected and prosperous while capitalizing on the benefits of the Internet of Things, interconnectivity and other technologies.

How cybersecurity can help small manufacturers:

Protecting your data.
The first step is to understand risks to your data. This involves identifying valuable company information and locating weak points in your systems' security. Potential breaches can then be **predicted – or prevented.**

Increasing your ability to detect, react and recover.
An incident response plan enables you to deal with various types of cyberattack, such as malware, phishing or social engineering. Having a plan in place heightens your company's chance of surviving these attacks. Each technology carries different risks, so it's important to think through the details of response plans before an attack.

Boosting your competitive advantage.
As data breaches increase, companies want to do business with other companies that protect themselves. Getting and keeping their business may depend on providing assurances that your company takes cybersecurity seriously and can be trusted to keep their information safe.

Maintain cybersecurity as you implement Industry 4.0 technologies

Any business owner knows that information is a vital part of running a company. As manufacturing increasingly becomes more digitized, cybersecurity must become a standard component of doing business. If sensitive information – such as employee records, customer transactions or proprietary data – is comprised, it can have a devastating effect. After a data breach, companies must regain their customers' trust, which can take a great deal of time and expense.

That's why more and more manufacturers are taking steps to protect their information via good information security practices. Cybersecurity may seem daunting because of costs or limited technical knowledge in your company. However, it's essential that everyone in the supply chain begins to develop practices to protect their – and their customers' – digital property.

According to the U.S. Department of Homeland Security, the manufacturing industry is the second most targeted industry for cyberattacks. Why? Cybercriminals view SMMs as prime targets because many don't have adequate preventative measures in place. They're incredibly vulnerable to cyberattack, which could result in:

- Loss of information critical to running the business
- Decreased productivity
- Damage to information or information systems
- Regulatory fines and penalties/legal fees
- An adverse reputation or loss of customer trust
- Damage to credit and inability to get bank loans
- Loss of income

So what is a smaller manufacturer to do? Fortunately, the National Institute of Standards and Technology (NIST) has developed a practical cybersecurity framework that can be implemented by businesses of any size. Available online, it can be further explained by local experts of the MEP National Network who can also help you implement cybersecurity best practices for the near and long-term.

Is Your Company Ready for Industry 4.0?

Manufacturers must be data driven and have a continuous improvement mindset to stay agile, innovate and deal with supply chain and other disruptions. The benefits of implementing Industry 4.0 technologies are clear, but many companies also face challenges. Your company must be ready for change. First, management must be on board. Decision-makers need to be part of the team from the start. Your workplace culture must support innovation, with employees open to training and change. In addition, your company must have good processes already in place. Otherwise, you'll simply speed up or automate bad processes.

Before implementing Industry 4.0 technologies, your company should consider:

- **Business practices.** Does your company focus on policies, processes, methods and rules in meeting company objectives? Are your operational procedures dependent on people? Are your business policies and processes well-documented? What about project, design or manufacturing plans – are those documented? Are you able to map your value stream (a representation of all activities required to produce a product)? Continuous improvement plays a critical role in implementing technology successfully – is it a focus at your company?
- **Enabling technologies.** While many manufacturers are just beginning their Industry 4.0 journey, some have already adopted technologies that support business operations and manage infrastructure. Is your company using sensors? Are you using technology to manage quality control? If so, you've already taken first steps that will smooth the way to further technology implementation.
- **Workforce development.** Employees play a critical role to the success of any technology implementation. Your workforce will need training so they have the skills to use new technology. Encourage them to share knowledge and best practices with each other – their soft skills like collaboration and communication will improve, as well.

The systems and institutional knowledge that contribute to a company's success can also make it difficult to change. Barriers can be seemingly small – like getting used to new reports in place of spreadsheets. Yet these small barriers can slow technology adoption down. Another issue can arise if employees view these technologies as a threat. For example, data provides detailed visibility of an organization's weaknesses that employees may take personally.

It's also important to identify technology providers that are a good fit for you and your company's needs. For example, will the provider upload your historical data into the system? Be sure to have detailed conversations early in the process with any provider.

Building a Business Case

The business case for technology adoption frequently centers around ROI and payback. These are financial metrics of the success of an investment and can be used to compare competing investment opportunities. They're useful metrics that require tangible, measurable benefits to compare against the total investment, as well as the investment period.

$$\text{Return on Investment} = \frac{\text{Incremental Gains}}{\text{Total Investment}} \quad \text{(expressed as \%)}$$

$$\text{Payback Period} = \frac{\text{Total Investment}}{\text{Annual Incremental Gains}} \quad \frac{\text{(expressed as years}}{\text{by 12 for months)}}$$

- **Identify the benefits**. In addition to tangible and financial benefits, a business case should also attempt to include intangible benefits of Industry 4.0 technology that could be challenging to measure. In the written portions of a business case, these can provide context and link implementation benefits to company strategy. Benefits to technology adoption include:

QUANTITATIVE BENEFITS

- Increased production
- Reduced scrap rate and quality improvements
- Reallocated labor hours
- Reduced labor hours at the process level
- Safety improvements such as reduced workers' compensation claims
- Increased utilization
- Work in progress (WIP) and cycle time reduction

QUALITATIVE BENEFITS

- Employee satisfaction
- Worker retention
- Attracting best talent
- Being seen as a technology forward company
- Keeping an edge over competition
- General safety improvements
- Production and lot tracking

Investment components. Your potential investment in Industry 4.0 technology is more than just the hardware. It's easy to overlook associated costs, especially as the technologies themselves become cheaper. Make sure you consider all applicable costs when evaluating a technology investment. These include:

Integration:

- Design engineering
- Installation
- Testing
- Ongoing support
- Additional programming needs

Internal costs:

- Technical and production team time (installation, test/acceptance trials)
- Training
- Loss of production revenue during installation and ramp up
- Hiring of additional technical personnel
- Finance costs

What's your goal for the technology? As part of the justification for the investment, you should determine what success will look like. How will it be measured? Improvement efforts sometimes fail in the long run because goals weren't clearly defined from the beginning. Your goal may be implementing your first collaborative robot. Or it may be getting data off one machine. Whatever it is, it should be plainly stated at the outset. If your goal involves moving a metric, then it's important to have a validated way to measure the before and after periods. Put all of this in your business case.

Preparing Your Employees for Industry 4.0

Change is scary for many people, especially in their work environment. When a company decides to implement new technology, employees might worry how it will impact them. How much of their job will change? Are they in danger of losing their job? Will they have to learn how to use the technology? There are ways to prepare your employees to embrace new technologies.

- **Include and empower your employees early.** Employees should be included from the earliest stage of your Industry 4.0 journey. Front line workers and managers are responsible for performing the work. They have an important perspective and can provide a wealth of information about which processes work well, where bottlenecks exist, and where there are areas for improvement. Their early involvement ensures that the new, automated process builds on the success of the older, manual process, while improving deficiencies. Small details like occasional process inconsistencies can throw a big wrench in an Industry 4.0 project. The team members who were in charge of the manual process will help head those issues off at the pass.
- **Get ahead of employee anxiety.** When employees are involved in the process, they are more open to change. They'll better understand why change is needed and how it will help them (and the company) improve. It's important to tell your employees that the new technology won't replace them, but that it may change the nature of their work. According to a WEF report, "Fewer than 5% of occupations consist of activities that are 100% automatable with today's technology, while 62% of occupations have at least 30% of automatable tasks."

- **Engage employees with skills development.** Gallop's "State of the American Workplace" reports that only 25% of manufacturing employees feel engaged. Giving your workers opportunities to learn new skills will help them become more engaged. The Society for Human Resource Management believes that investing in employees can set you up for success and ultimately save you money. Developing a strong employee development program that grows their skills will help build loyalty – and help you retain your best workers.
- **Identify an Industry 4.0 champion at your company.** Implementation is just the first step. The work really begins when your team starts using the new technology. To ensure rapid ROI and ongoing success, identify an in-house champion who will work alongside the implementation team and learn the system. Make sure this person has cross-departmental authority and can broker engineering and production cooperation, which will be critical to long-term success.
- **Let go of old processes.** Introducing a new technology into your facility is a big change. There are lots of variables to any project of any scale. Don't complicate the situation by keeping the old process in place. Old and new processes running in tandem don't work. For example, if you purchase a new ERP system to manage your production schedule, then get rid of the old production schedule spreadsheet. Spend time up front inputting data and preparing so you only use the new system moving forward.
- **Embrace a new mindset.** Adopting Industry 4.0 technologies requires a new mindset. These technologies don't simply improve an existing process. They create a completely new process. This can be intimidating for employees at all levels, but your project's success requires that they all buy into this new mindset.

Your Local MEP Center Can Help You on Your Industry 4.0 Journey

MEP Center Industry 4.0 experts provide unbiased recommendations for applying advanced manufacturing technology to improve your operation. Our experts will work with you to understand your unique needs, identify opportunities where technology will have an impact and propose solutions that are right for your business. Our experts:

- Start by assessing your company's current situation
- Identify opportunities and help you prioritize processes where technology solves problems or generates the greatest benefit
- Help you develop a business case
- Implement solutions
- Rigorously measure results

Contact your local MEP Center

MEP National Network™

The MEP National Network is a unique public-private partnership that delivers comprehensive, proven solutions to U.S. manufacturers, fueling growth and advancing U.S. manufacturing.

Focused on helping small and medium-sized manufacturers generate business results and thrive in today's technology-driven economy, the MEP National Network comprises the National Institute of Standards and Technology's Manufacturing Extension Partnership (NIST MEP) and 51 MEP Centers located in all 50 states and Puerto Rico.

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