AUTOMATION

Automation in the digital economy refers to the use of technology to perform repetitive tasks with minimal human intervention. This can include tasks such as data entry, customer support, manufacturing processes, and supply chain management. Automation boosts productivity, reduces operational costs, and improves accuracy. Robotics, AI, and software automation are key drivers of efficiency in sectors like manufacturing, logistics, and customer service. In business, automation allows companies to focus on strategic growth areas, with routine and low-value tasks being handled by machines. Manufacturers face challenging balancing acts: produce more while spending less, create customized products but use standard processes, reduce technology debt and time to market. Global networks and the revolution of digital technologies have accelerated and streamlined the product manufacturing value chain from end to end. Digital manufacturing represents an evolution of traditional manufacturing. Traditional manufacturing is a broad term that refers to a wide range of industrial processes that convert raw materials into finished products. Digital manufacturing is an integrated approach to manufacturing that uses computer systems to improve machines, processes, and productivity. The automation of digital manufacturing systems and processes represents yet another evolution in manufacturing, enabling significantly improved efficiency and product quality, reduced labor costs, increased accuracy, safety, and production capacity. Potentially transformative though it is, automation in digital manufacturing comes with a set of significant hurdles for manufacturers to clear before they're able to reap the full benefits. Initial investment costs can be prohibitive and the return on investment for automation in digital manufacturing may not be immediate. Challenges notwithstanding, increased automation of digital manufacturing has the potential to radically transform the industry, allowing manufacturing companies to gain real-time insight into factory processes and better integrate manufacturing systems with user experience to reinvent how operators interact with the plant.

Automation: Enhancing the efficiency and quality of the manufacturing process

Automation in digital manufacturing refers to the use of advanced technologies such as robotics, artificial intelligence, machine learning, and the Internet of Things (IoT) to enhance the efficiency and quality of manufacturing processes. Automation eliminates the need for human intervention in repetitive, time-consuming, and potentially dangerous tasks, resulting in faster and more consistent production. It involves the integration of hardware, software, and

communication technologies to optimize the entire manufacturing process from design to delivery.

Automation is crucial in digital manufacturing as it can significantly improve the efficiency, accuracy, and safety of the manufacturing process. By automating repetitive and timeconsuming tasks, manufacturers can increase their production capacity, reduce labor costs, and improve product quality. In short, well-implemented automation can measurably improve a manufacturer's Overall Equipment Effectiveness (OEE). A metric used to determine how well a manufacturing operation is utilizing key resources, as well as minimizing negative factors like unused waste and unintentional downtime. Automation also enables manufacturers to collect real-time data from the manufacturing process, which can be used to proactively identify and diagnose potential issues, leading to better quality control and fewer defects. Additionally, automation can help reduce the environmental impact of manufacturing by optimizing energy usage and minimizing waste.

In this article, we'll review the benefits and challenges of applying automation to digital manufacturing, types of automation technology, the future of automation in the digital manufacturing industry, and recommendations for digital manufacturing companies beginning their digital transformation journey.

Benefits of automating digital manufacturing

Automating digital manufacturing increases efficiency, agility, and production capacity, reduces costs, improves quality control, and enhances safety.

According to McKinsey, digital manufacturers who implement automation can expect to "see 30 to 50 percent reductions in machine downtime, 10 to 30 percent increases in throughput, 15 to 30 percent improvements in labor productivity, and 85 percent more accurate forecasting".

Increased efficiency

Automation can optimize the entire manufacturing process from design to delivery, resulting in a more streamlined and efficient workflow that eliminates the need for human intervention in repetitive and time-consuming tasks. Last but not least, automation can improve the accuracy of manufacturing processes. Using sensors and other advanced technologies, machines can detect and correct issues in real-time, resulting in higher-quality products.

Reduced costs

Automation in digital manufacturing can significantly reduce costs in several ways. By automating repetitive and time-consuming tasks, manufacturers can reduce labor costs and increase production capacity without having to hire additional workers. Automation can optimize the use of raw materials and energy, reducing waste and minimizing the costs associated with excess inventory. Automation can also improve product quality, minimizing the costs associated with defects and rework. Regularly scheduled maintenance and proactive identification of potential issues can reduce costs associated with equipment failure.

Improved quality control

Automation in digital manufacturing can improve quality control by detecting defects in products before they're shipped, reducing the need for rework. Automation can help standardize manufacturing processes, ensuring consistent quality. Automated systems can be programmed to follow strict guidelines and specifications, ensuring that each product meets the same high standards. Automation in digital manufacturing can improve quality control by reducing errors, standardizing the manufacturing process, and proactively identifying potential issues.

Increased agility

Business agility is essential for manufacturers to compete in today's global economy. By embracing automated digital manufacturing, manufacturers can improve their flexibility, responsiveness, and efficiency, which can help them to achieve business agility and thrive in the face of change. Automation can help manufacturers become more agile and responsive to changes in demand. AI-powered production planning systems can help manufacturers quickly adjust their production plans to meet changing customer needs.

Enhanced safety

Automating repetitive and potentially dangerous tasks can reduce the likelihood of workplace accidents and injuries, minimize exposure to hazardous materials, and create a more ergonomic working environment. Automated systems and robots can be used to handle and transport hazardous materials, minimizing the risk of exposure to human workers. Automation

can help to reduce the risk of human error and can also help create a more ergonomic working environment, reducing the risk of repetitive strain injuries and other musculoskeletal disorders.

Increased production capacity

Automation in digital manufacturing can increase production capacity by minimizing human error, optimizing workflows, and improving product quality, resulting in faster and more efficient production. Automated systems can help to monitor inventory levels, track the progress of orders, and schedule maintenance tasks to minimize downtime, reducing the risk of delays. Implementing automation in digital manufacturing optimizes the entire manufacturing process, improving accuracy and reducing waste and error.

Types of automation in digital manufacturing

Fixed Automation

Fixed automation, also known as hard automation, is a system that performs a specific task and is difficult to reconfigure for different product styles. It is characterized by high production rates and a high initial investment. Programming is built into machines using cams, gears, wiring, and other hardware. Fixed automation is well-suited for mass-produced products, such as the machining transfer lines used in the automotive industry, automatic assembly machines, and certain chemical processes. Changeovers are possible, but they require shutting down the line and manually swapping out tooling.

Programmable automation

Programmable automation allows manufacturers to produce products in batches, ranging from a few dozen to several thousand units at a time. This type of automation requires reprogramming and changing equipment for each new batch, which results in downtime. Programmable automation generally has lower production rates than fixed automation because it is designed to facilitate product changeover. The high cost of downtime has led to the development of flexible automation, which is an extension of programmable automation.

Flexible automation

The key disadvantage of programmable automation is downtime during equipment changeover for new products. Flexible automation is an extension that addresses this issue by automating changeovers. However, it can limit equipment to running parts that share similar tools or require additional devices for changeovers. This means that flexible automation supports a

much smaller variety of products to ensure quick automatic changeovers. Flexible automation is often connected to a network, which adds value by enabling remote operation of production.

It also eliminates batch production, allowing for the simultaneous production of different products.

Types of technology used to automate digital manufacturing

Robotics

Robotics are a key technology used to automate digital manufacturing. Robots used in digital manufacturing are often equipped with sensors, cameras, and other advanced technologies that allow them to detect and correct issues in real-time. Cameras can be used to inspect products for defects, while sensors can be used to monitor temperature, pressure, and other variables.

Robots can perform a wide range of tasks, from handling and transporting materials to assembling components and performing quality control checks. Robots are particularly useful for automating repetitive, time-consuming, or dangerous tasks that would otherwise require human intervention.

Artificial intelligence

AI is a powerful tool for automating many tasks in digital manufacturing. Here are some specific examples of how AI is being used to automate digital manufacturing:

- **Robotics:** AI is being used to develop robots for manufacturing that can be programmed to perform a variety of complex tasks such as welding, painting, and assembly with high precision and accuracy.
- **Predictive maintenance:** Artificial intelligence can be used to analyze sensor data from equipment to predict likely time to failure, allowing manufacturers to proactively schedule maintenance to avoid costly downtime.
- **Quality control:** AI can be used to inspect products for defects using machine vision and image processing, helping to improve product quality and reduce waste.
- **AI-powered production planning systems:** Artificial intelligence is being used to develop production planning systems that can optimize production plans and schedules. These systems can help manufacturers to improve efficiency, reduce costs, and meet customer demand more effectively.

- **Supply chain management:** AI can optimize supply chains to improve efficiency and reduce costs by forecasting demand, managing inventory, and optimizing transportation routes.
- **AI-powered quality control systems:** Artificial intelligence is being used to develop quality control systems that can inspect a wide variety of products, including food, pharmaceuticals, and electronics, for defects at high speed, with high accuracy.

Machine learning

Machine learning uses algorithms and statistical models to enable machines to learn from data and improve their performance without being explicitly programmed. Machine learning can improve the efficiency, quality, and safety of digital manufacturing and can be used to automate several aspects of digital manufacturing, including quality control, predictive maintenance, and optimization of manufacturing processes.

Machine learning can be used to adjust the production process to minimize waste and reduce energy consumption by analyzing data from sensors and other sources, leading to reduced costs and improved efficiency. Machine learning algorithms can identify patterns and anomalies in the manufacturing process, optimize the process based on the data, and improve product quality.

Internet of Things (IoT)

The Internet of Things (IoT) uses sensors, actuators, and other devices connected to the internet to collect and exchange data. IoT is an advanced technology that can be used to automate several aspects of digital manufacturing, including predictive maintenance, inventory management, and quality control.

IoT sensors can be used to monitor the performance of machines and equipment in real-time. The data collected can be analyzed using machine learning algorithms to identify patterns and anomalies that may indicate potential issues. Equipment can be adjusted or repaired before a failure occurs, minimizing downtime and reducing maintenance costs.

IoT can optimize inventory levels, reduce waste, and automate inventory management by using sensors to track the levels of raw materials and finished products. IoT can also be used to track the progress of orders and shipments, ensuring that products are delivered on time and in good condition.

IoT can automate quality control by using sensors to detect defects in products, identify the root cause of the problem, and adjust the manufacturing process to prevent similar defects from occurring in the future. **Challenges**

Initial investment cost

The initial investment outlay for automation in digital manufacturing can be prohibitive for several reasons. The cost of advanced technologies such as robotics, artificial intelligence, machine learning, and the Internet of Things (IoT) can be high, making it difficult for smaller companies to invest in automation, as they may not have the financial resources to make the initial investment.

Automation in digital manufacturing involves the integration of new hardware, software, and communication technologies with legacy systems to optimize the entire manufacturing process from design to delivery. The cost of integrating these different technologies and systems can be high and requires expertise in several areas, including engineering, computer science, and data analysis. Hiring experts for each of these areas can be cost prohibitive.

Applying automation to digital manufacturing often involves the reorganization of the manufacturing processes, which can require employees to learn new skills and work with new tools and systems. Training and retraining employees involves significant cost, both in terms of time and financial resources.

Also, the return on investment for automating digital manufacturing may not be immediate. While automation can lead to significant cost savings and productivity gains in the long run, it may take some time for these benefits to materialize. This can make it difficult for companies to justify the initial investment.

Workforce training and skill set requirements

Workforce training and skill set requirements can pose a challenge for manufacturers seeking to integrate automation technology into digital manufacturing operations. One of the biggest challenges is the need to retrain the existing workforce on the new technology. This requires a significant investment of time and resources to ensure that employees have the necessary skills and knowledge to operate and maintain the new technology.

Furthermore, new automation technology may require a different skill set than the existing workforce possesses. For example, new automation technology may require expertise in

computer programming, data analysis, and systems integration, which may not be available in the existing workforce. This can lead to a skills gap that can be difficult to bridge, particularly in areas with a shortage of skilled workers.

The adoption of new automation technology can lead to job displacement, which can create anxiety and uncertainty among employees. This can lead to resistance to change and make it difficult to implement new technology.

To address these challenges, manufacturers should invest in workforce training and development programs to ensure that employees have the necessary skills and knowledge to work with new automation technology. Providing training in areas such as computer programming, data analysis, and systems integration and training on new processes and workflows can help alleviate worker anxiety and resistance to change.

To alleviate anxiety, uncertainty, and ensure that the workforce is supportive of the new automation technology, manufacturers need to communicate the benefits to the workforce and involve them in the implementation process.

Workforce training and skill set requirements can pose a challenge for manufacturers seeking to integrate automation technology into digital manufacturing operations. However, with the right investment in training and development programs and effective communication, these challenges can be overcome.

Integration with existing technology

Integrating automation technology with existing technology can pose several challenges. One of the biggest challenges is the need to ensure compatibility between the new automation technology and legacy systems. This can be particularly challenging when the existing systems are outdated or use proprietary technology that is not easily adaptable to new systems.

Another challenge is the need to reorganize the manufacturing process to accommodate the new automation technology. This may require changes to the layout of the factory floor, modifications to the existing equipment, and the adoption of new processes and workflows which can be a time-consuming, costly, and require careful planning and execution.

In addition, integrating automation technology with existing technology can pose challenges in terms of employee training and retraining. The new technology may require new skills and

knowledge that employees may not possess, leading to a significant learning curve that can result in a temporary decrease in productivity as employees adjust.

Finally, integrating automation technology with existing technology can pose challenges in terms of data management. Automation technology generates large amounts of data that must be collected, analyzed, and stored, placing a strain on existing data management systems, and requiring the adoption of new data management tools and techniques.

Integrating automation technology with existing technology in the digital manufacturing industry can pose several challenges, including compatibility issues, reorganization of the manufacturing process, employee training, and data management. Manufacturers need to carefully plan and execute the integration process to ensure that it is successful and delivers the desired benefits.

Cybersecurity risks

Integrating automation into digital manufacturing operations can bring many benefits, but it also poses several cybersecurity risks. One of the biggest risks is the possibility of cyberattacks on the automated

systems. As automation systems become more connected to the internet, they become more vulnerable to cyberattacks by hackers who can gain unauthorized access to the systems and cause damage.

Cyberattacks on automated systems can disrupt the manufacturing process, cause damage to equipment, and compromise the safety of employees. Cyberattacks can also result in the theft of sensitive data and intellectual property, which can have severe financial and reputational consequences for the manufacturer.

Another cybersecurity risk of integrating automation into digital manufacturing operations is the possibility of insider threats. Insider threats come from employees who have access to the automation systems and use that access to steal data or cause damage. These threats can be intentional or unintentional, and they can be difficult to detect and prevent.

To mitigate these cybersecurity risks, manufacturers need to implement robust cybersecurity measures. These measures should include using firewalls and intrusion detection systems to protect the automation systems from cyberattacks, implementing access controls to limit employee access to sensitive data and systems, and conducting regular cybersecurity training

to educate employees about risks and threats. It's also important to conduct regular security assessments and vulnerability testing to identify and address any weaknesses in the automation systems.

Potential impact on workforce

The potential impact of automation on the digital manufacturing workforce is significant. While automation can bring many benefits, such as increased efficiency, improved quality, and reduced costs, it can also lead to job displacement and changes in the skill sets required for manufacturing jobs.

Automation in digital manufacturing can replace human workers in repetitive, time-consuming tasks, and can also perform tasks that are too dangerous or difficult for humans to perform. This can lead to reduced demand for certain types of jobs, such as manual labor or routine tasks. However, it can also create new job opportunities in areas such as data analysis, machine programming, and maintenance.

Furthermore, automation can change the skill sets required for manufacturing jobs. As automation technology becomes more advanced, it may require more specialized skills, such as computer programming, data analysis, and systems integration. This can create a skills gap, where the existing workforce may not have the necessary skills to work with the new technology.

To address these challenges, manufacturers need to invest in workforce training and development programs to ensure that employees have the necessary skills and knowledge to work with the new technology. This can involve providing training in areas such as computer programming, data analysis, and systems integration. It can also involve providing training on new processes and workflows.

Overall, automation in digital manufacturing has the potential to significantly impact the workforce. While it can lead to job displacement and changes in skill sets required for manufacturing jobs, it can also create new job opportunities and increase productivity and efficiency. Manufacturers need to be proactive in addressing these challenges and investing in workforce training and development to ensure a smooth transition to automation.

Sustainability and environmental impact

Industry 5.0 is the next generation of manufacturing, which builds on the Industry 4.0 revolution by putting humans back at the center of production processes. Industry 5.0 is a human-centric, resilient, and sustainable industrial paradigm that aims to create a more equitable and sustainable society through the integration of advanced technologies with human values and capabilities.

Industry 5.0 builds on the foundation of Industry 4.0, which focused on automation and efficiency. However, Industry 5.0 places a greater emphasis on the human element, recognizing that the best outcomes are achieved when humans and machines work together in harmony.

Automation in digital manufacturing has the potential to bring several sustainability and environmental benefits. Manufacturers can play a crucial role in reducing the environmental impact of manufacturing operations by adopting automation technologies that enable more sustainable and efficient manufacturing practices.

Here are some of the ways in which automation can create a more equitable and sustainable society and contribute to sustainability while reducing environmental impact:

- **Energy Efficiency:** Automation in digital manufacturing can optimize the use of energy by monitoring and controlling energy consumption in real-time. This can help to reduce energy waste and minimize the carbon footprint of manufacturing operations.
- **Waste Reduction:** Automation can help to reduce waste by optimizing the use of raw materials and minimizing overproduction. By using sensors and other advanced technologies, machines can detect and correct issues in real-time, reducing the need for manual intervention and resulting in less waste.
- **Recycling:** Automation can also help to increase recycling by enabling the separation and sorting of materials more efficiently. This can help to reduce the amount of waste that ends up in landfills and contribute to a circular economy.
- **Environmental Monitoring:** Automation can enable real-time monitoring of environmental conditions, such as air and water quality, to ensure compliance with environmental regulations. This can help to minimize the environmental impact of manufacturing operations and protect the health and safety of employees.

- **Creating new jobs and opportunities:** As Industry 5.0 automation technologies become more widely adopted, new jobs will be created in areas such as data science, artificial intelligence, and robotics. Industry 5.0 automation will create new opportunities for workers to upskill and reskill, so that they can stay ahead of the curve in the changing workforce.
- **Reducing poverty and inequality:** Automation technologies can be used to create more inclusive and equitable workplaces. Industry 5.0 automation technologies can be used to develop new products and services that are more accessible and affordable for people from all walks of life.
- **Protecting the environment:** Automation technologies can be used to reduce the environmental impact of industry, develop renewable energy sources, reduce waste, improve energy efficiency, and create more sustainable products and services.

The future of automation in digital manufacturing

Advancements in technology are shaping the future of digital manufacturing in several ways. Here are some of the key advancements that are likely to have a significant impact on the industry:

Additive Manufacturing: Additive manufacturing, or 3D printing, is a technology that allows manufacturers to create complex parts and components using digital design files. This technology offers several benefits, including the ability to produce parts on demand, reduce waste, and improve the speed and accuracy of the manufacturing process.

Digital Twins: Digital twins are virtual replicas of physical objects or systems. In digital manufacturing, digital twins can be used to simulate the manufacturing process, identify potential issues before they occur, and optimize the production process. They can also be used to monitor the performance of machines and equipment in real-time and predict maintenance needs.

Recommendations for digital manufacturing businesses considering automation

1. **Start with a clear strategy:** Define your goals and objectives for automation and develop a clear strategy for how automation will support your business operations and growth.

2. **Conduct a thorough assessment:** Conduct a thorough assessment of your manufacturing processes and systems to identify areas where automation can bring the most significant benefits.

3. **Prioritize cybersecurity:** Prioritize cybersecurity in your automation strategy by implementing robust cybersecurity measures to protect your automated systems from cyberattacks and insider threats.

4. **Invest in workforce training:** Invest in workforce training and development programs to ensure that employees have the necessary skills and knowledge to work with the new automation technology.

5. **Be patient and flexible:** Be patient and flexible in the implementation of automation, as it may require changes to your existing systems and processes. Allow for a learning curve as employees adjust to the new technology and be open to adjusting as needed.

6. **Learn from others:** Learn from other businesses that have implemented automation to gain insights into best practices and potential challenges.

Automation has the potential to bring significant benefits to your digital manufacturing business, including increased efficiency, improved quality, and reduced costs. By finding an experienced implementation partner, you can successfully integrate automation into your manufacturing operations and achieve your business goals.

By evaluating your factory's unique environment, Stefanini can provide custom OT and IT service integration. Our Smart Manufacturing solutions connect our clients with a team of experts who redesign your system from R&D to production and even customer delivery and support. AI can advise on new processes, and digital twin technology can allow you to test and retest those processes before implementation. Our priorities reflect your objectives like increased efficiency, asset reliability, decreased O&M cost, and reduced operational risk.