Generative AI for Smart Manufacturing:

A Guide to Accelerating Innovation

The manufacturing industry is no stranger to the power of artificial intelligence (AI). Many manufacturers are already leveraging the technology across an array of applications, improving their competitive advantage and bottom line by achieving enhanced forecasting, reduced downtime, increased production precision and more. Thus, it's no surprise that 76% of IT leaders believe GenAI will be significant if not transformative for their organization.

Yet, these applications may only scratch the surface of what AI can offer manufacturers. An exciting new era has arrived with generative AI ("GenAI"). GenAI introduces new capabilities that can automate and accelerate tasks using trusted and validated data to produce net-new content that leverages even more data points across the entire manufacturing ecosystem.

In this ebook, experts from Dell Technologies and Intel present three initial use cases for GenAI in manufacturing and offer advice on unlocking the technology's potential.

Advantages of GenAI in Modern Manufacturing

"Rapid advances in technology for sustainability, digital twins, and generative AI are converging to create unprecedented opportunities that are redefining what manufacturing can be."

– TODD EDMUNDS
Global CTO for Manufacturing at Dell Technologies

While GenAI has enormous potential to transform manufacturing processes and operations, traditional AI has historically supported the majority of manufacturing use cases. These AI models and systems can learn to identify patterns in a manufacturer's data and use the learnings to make predictions or decisions.

In recent years, increasing accessibility has greatly improved the appeal of GenAI — including deep learning. Advanced technologies that were once complex and expensive have become more mainstream and affordable, enabling more manufacturers to leverage GenAI systems in innovative ways. The latest GenAI solutions enable manufacturers to utilize their own data and intellectual property to drive improvements in a highly scalable way — one that allows them to maintain their competitive edge and protect sensitive information.

Todd Edmunds, global CTO for manufacturing at Dell Technologies, indicates, "Rapid advances in technology for sustainability, digital twins, and generative AI are converging to create unprecedented opportunities that are redefining what manufacturing can be."

What Makes GenAI Different?

It Starts With the Power of Data

Since introducing sensors to the factory floor, plants have collected data to better understand machine performance, product quality, equipment health and energy consumption. Unfortunately, in many cases, that data is in siloes, so it is not used to its full potential, and it may not be used at all.

Generative AI presents the opportunity to utilize extensive data from the entire manufacturing ecosystem to produce net-new outputs, uncovering levels of efficiency and driving extraordinary outcomes that were once beyond imagination.

Rita Wouhaybi is a senior AI principal engineer at Intel Corporation, which partners with Dell Technologies to provide AI solutions that meet customers wherever they may be on their AI journey. She explains, "We have become community data hoarders. We love to collect data. A big opportunity with generative AI will be making sense out of these big chunks of data sitting in private repositories."

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What Makes GenAI Different?

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GenAI helps analyze data at scale and speed.

Currently, AI can analyze vast amounts of data with incredible speed. It is often used to define rules that generate descriptive and diagnostic results, such as a production error or a security risk. GenAI allows manufacturers to use data much more ambitiously, enabling a more predictive approach especially when that data is collected with specific use cases in mind.

Wouhaybi adds, "A lot of intelligence can be created by monitoring log files. But IT professionals lose sleep looking at them — like searching for a needle in a haystack. This challenge makes 'log files' prime candidates for the summarization ability of large language models. And with GenAI, we can take it further by predicting what is about to happen."

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What Makes GenAI Different?

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GenAI provides new predictions/recommendations based on the manufacturer's own data.

Many manufacturers have incorporated traditional AI into operational processes and production by integrating rule-based systems and machine learning models that are trained to perform specific tasks or optimize predefined processes. These systems and models rely on explicit instructions and historical data to make decisions.

GenAI takes the power of data further, enabling manufacturers to use their data to train systems and models to identify patterns and, when prompted, generate a new, similar pattern or outputs based on the new pattern.

Edmunds emphasizes that it's important to ensure you're able to get enough of the right data for any AI use case. "While plant data may be available for specific use cases, you need to have the systems in place to get it, format it, process it and store it for AI to work its magic."

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GenAI Use Case 1:
Enhanced Product Design

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"When you're producing a new product with GenAI and artificial intelligence models, you can prototype faster, test faster and fail faster. Every iteration generates more data that is compounded into the system and provides more insights."

– WILLIE REED
General Manager, Global Industries, Manufacturing & Retail at Dell Technologies

AI is generally used for tasks that can be challenging or time-consuming for humans — like examining various types of data to extrapolate helpful information, create connection points and make predictions. These advantages align perfectly with the product design process.

With GenAI, manufacturers can ask questions and expect meaningful, relevant answers. For example:

- How can we make a better product?
- Can we develop it faster, easier or cheaper?
- Will different materials yield better results?

In addition to innovative product design, GenAI offers continual opportunities to ask "What if...?" questions.

For example, an engineering company using GenAI to design bridges can leverage its historical data from projects it has already finished to determine whether a new build option will be viable. A manufacturing company can leverage GenAI to rapidly generate and test multiple design prototypes. Then, with a digital twin of the factory, they could virtually simulate the manufacturability of the designs. The ability to incorporate past production data and customer feedback into new iterations could enable improved efficiency, cost-effectiveness, continually improved products, increased speed to market and greater customer satisfaction.

Willie Reed, general manager of global industries for manufacturing & retail at Dell Technologies, explains, "When you're producing a new product with GenAI and artificial intelligence models, you can prototype faster, test faster and fail faster. Every iteration generates more data that is compounded into the system and provides more insights."

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GenAI Use Case 2:

Optimized Production Processes

GenAI brings a wealth of potential for improving production processes, from greater efficiency to better waste reduction to smarter resource management.

Imagine GenAI transforming production scheduling — everything from machine availability to workforce dynamics to customer demand patterns. It can even simulate wear on products and equipment to inform timely maintenance decisions.

GenAI's maintenance capabilities are especially noteworthy. It has the potential to prevent equipment failures, recommend proactive maintenance schedules and possibly even autonomously order parts. This application could be invaluable for large enterprises that stand to lose large amounts of money for every hour of unplanned downtime.*

Moreover, GenAI's integration with machine learning promises dynamic production lines. These lines could self-tune in response to ongoing production data, continuously enhancing the manufacturing process to work more effectively and efficiently.

"Imagine GenAI integrated with the control systems running machines on the factory floor, like programmable logic controllers (PLC) and manufacturing execution systems (MES)," says Edmunds. "It can optimize them to work together to produce more, faster and with less cost."

* Source: The True Cost of Downtime 2022, Siemens

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Spotlight on Digital Twin Technology

Digital twin technology — virtual representations of real-world assets, processes or organizations — can offer huge benefits throughout the entire design, production and operation stages, and GenAI can raise its impact even further.

According to Pieter Van Schalkwyk, CEO at XMPro, digital twins can help you answer three key operational questions:*

- "Tell Me What Is Going On"

- "Tell Me What I Should Be Doing"

- "Tell Me What If"

When combined with GenAI, digital twins allow manufacturers to simulate multiple outcomes, make changes virtually and see the possible results — without touching the actual product or equipment.

For example, GenAI could support a digital twin of a robot in an auto parts plant. The twin uses sensors to monitor the robot's performance and conditions, such as gearbox temperature. GenAI could then use that data to provide real-time insights and predictive maintenance recommendations, such as when a joint requires replacing.

GenAI, combined with digital twin technology, opens a wealth of possibilities that can improve product design and production, including testing products and equipment under various environmental conditions, maintenance schedules and design changes.

Source: "How To Hire The Right Digital Twin For Your Company," Forbes

GenAI Use Case 3:
Improved Supply Chain Management
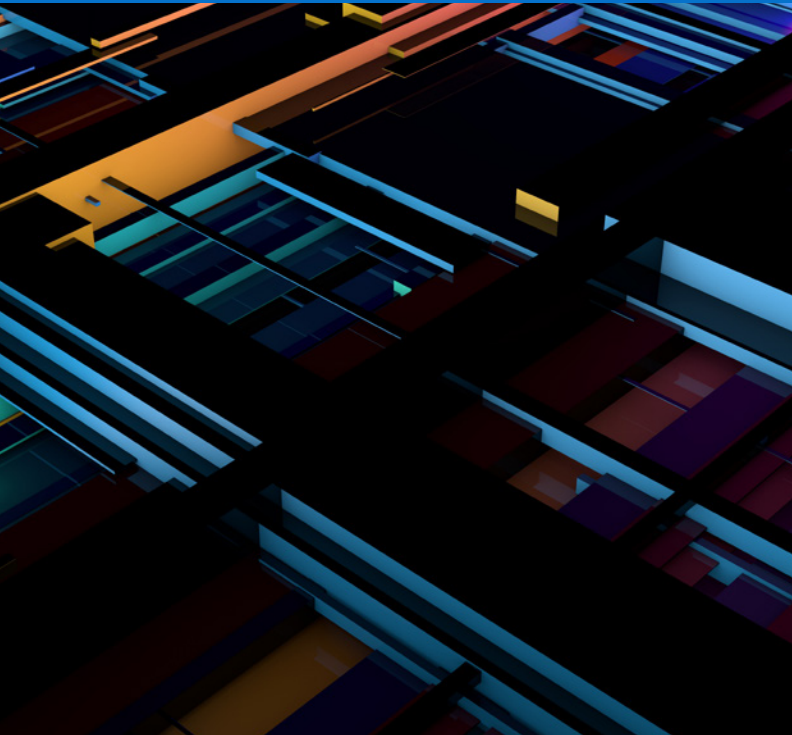
GenAI's ability to analyze large datasets, simulate scenarios and provide intelligent insights makes it a valuable tool for optimizing various aspects of a manufacturer's supply chain.

Traditional AI enables real-time monitoring of the supply chain to help track the movement of goods, keep tabs on inventory levels and receive alerts for potential disruptions. GenAI can take this further by suggesting the most efficient alternate routes and re-routing shipments when disruptions occur.

Other opportunities include the ability to analyze market conditions and competitor pricing to suggest and even implement dynamic pricing strategies. This application would enable pricing based on real-time demand and supply dynamics to maximize revenue and optimize inventory turnover.

By using GenAI to simulate what might happen if a particular supplier has a disruption, manufacturers can find alternative solutions for product or raw material sourcing. This information enables them to adjust schedules, eliminate overstock, minimize the risk of inventory shortages and build a more resilient supply chain, as necessary.

As the GenAI model learns organizational processes and receives updates based on changing conditions, it may even be able to autonomously reconfigure to meet changing demands in real time.

"Generative AI will offer so much to smart manufacturers," says Bill Schmarzo, customer advocate for data management incubation at Dell Technologies. "We're moving towards an ideal environment that can self-monitor, self-diagnose and self-heal. As the environmental, economic and market conditions change, these systems will monitor, learn and adapt accordingly."

Clearly Defined Objectives Are Critical in GenAI Use Case Selection

We're just starting to scratch the surface of how GenAI will impact large manufacturers. As the industry moves forward, applications will roll out quickly. It will be tempting to use GenAI in as many areas as possible.

However, clarity around business goals is critical for successful implementation. Organizations can expect a significant return on investment in GenAI, but they need to be crystal clear on the problem they're trying to solve, the desired outcomes and the metrics they'll use to measure success. Only then can they transform their data into the format required to support and address their prioritized use cases.

"Organizations don't fail because they lack use cases, but because they have too many options," notes Schmarzo. "Executives must go through a thoughtful, collaborative process, bringing together all the key stakeholders to identify, validate, value and prioritize the use cases they want to go after — and target use cases they can deliver within 9-12 months."

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– BILL SCHMARZO
Customer Advocate for Data Management Incubation at Dell Technologies

4 Key Considerations for Implementing GenAI in Manufacturing

AI is constantly evolving, as is its power to transform manufacturing. Companies that fail to move on GenAI may find themselves with outdated business models, rising costs, inefficient production and the inability to compete in the evolving market.

While the options can feel overwhelming, there are steps you can take now to move the needle. Consider the following four areas to address:

1. Strategy

To get the most out of GenAI, organizations must tie traditional and generative AI capabilities and expectations to their business challenges and objectives. Setting a strategy should include a collaborative process that helps you identify the problems to solve, determine the data to collect and analyze, and create a roadmap for reaching your goals.

2. Infrastructure

Modern scalable infrastructure is a critical component for AI success, both at the data source (the factory) and with the high-level computing power and capabilities required to:

- Store, protect and backup the required datasets.

- Train and use the large language models that provide a foundation for GenAI.

- Monitor performance and make recommendations.

- Scale, manage and replicate across the organization.

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3. Solutions

Effective solutions are vital for integrating GenAI into your manufacturing operations — for example, systems capable of storing, processing and utilizing large volumes of data. This forms the backbone of GenAI's functionality.

Equally important is the seamless transfer of data and AI models between various storage platforms, from local servers to the cloud, to ensure scalability and accessibility. Compliance and security are also paramount. Enterprises must ensure that all data handling complies with legal standards and is secure, utilizing tools like encryption and secure transfer protocols.

By focusing on these solutions — efficient data management, seamless data transfer, security and compliance — manufacturers can prepare to leverage GenAI to its fullest potential.

4. People

When implementing GenAI in a facility, it's vital to have the right people trained and accessible. They can either come from within the manufacturing company or be brought in by hiring or partnering with specialists. Identifying the skills and talent needed — and ensuring you have access to them — is essential to achieving the required outcomes, such as cost reductions, faster go-to-market, etc.

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Comprehensive Generative AI Solutions for Large-Scale Manufacturers

Generative AI (GenAI) is a powerful tool for large-scale manufacturers who want to create new products, optimize processes and enhance quality. However, implementing GenAI solutions can be complex and challenging. You need to find the right AI infrastructure, integrate it with your existing equipment and manage it effectively.

Dell Technologies can help you simplify and accelerate your GenAI journey. We offer technology solutions for the generative AI era. Our Enterprise Edge Validated Design solutions offer a process that allows customers to identify desired outcomes and deliver the workflows needed at scale, thus minimizing risk and accelerating implementation and helping you deploy and manage GenAI applications that provide more intelligent results in less time. Whether you are starting your GenAI journey or scaling it up, Dell Technologies can help you leverage the best GenAI platforms for your use cases. We collaborate with leading partners like Intel to provide innovative technologies and proven expertise. We also help you future-proof your production lines with strategies and solutions that enable seamless adoption of new technologies.

With Dell Technologies, you can harness the power of GenAI to transform your manufacturing operations and achieve new levels of innovation and excellence.

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