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POV

Potential Use Cases for Generative AI in Manufacturing

Overview

The manufacturing industry has experienced remarkable transformations over the last century. Starting with rapid industrialization, which first began in Britain in the 1800s riding on steam power during the Industry 1.0 era, the manufacturing sector transformed in the 2000s, which was the era of Industry 4.0. Now, we are in the AI age where it is widely argued that machines will be smarter than man. AI has already entered and revolutionized multiple aspects of our lives, ranging from healthcare, advertising, and personalized recommendations on social media to even the way we buy groceries. But its impact on manufacturing is yet to be realized completely. With the advent of Generative AI (or Gen AI as it is popularly called) that claims to know anything and everything under the sky and create any type of content as demanded, how can manufacturing not be impacted? Manufacturing is a data-driven field. AI has been successful so far due to availability of a wide variety and volume of data which is called big data. As manufacturing processes have numerous variables that are often hard to understand and manage while simultaneously deriving relevant and actionable insights, generative AI or ML can be a good candidate to fit into this scheme of things. In this point of view (PoV), let's dive into the exciting world of generative AI in manufacturing and explore how it works and delivers benefits to manufacturers.

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Use cases

This PoV explores four important manufacturing areas where Gen AI can potentially bring about a positive impact.

Process manufacturing

Process manufacturing can benefit from generative AI in numerous ways. Process intensive industries such as power and utilities or cement plants have numerous constraints, interlocks, and vast volumes of machine data. Generative AI models can be trained in supervised or unsupervised ways on this data for deriving actionable insights that can improve Overall Equipment Effectiveness (OEE), productivity and reduce operational costs **(illustrated in Figure 1).** One application of generative AI is analyzing machine sensor data to predict the timing of equipment failures, allowing manufacturers to proactively schedule maintenance and repairs. This proactive approach reduces downtime and enhances overall equipment performance. Moreover, generative AI can also identify patterns in production data to optimize productivity, reduce costs, and enhance efficiency.

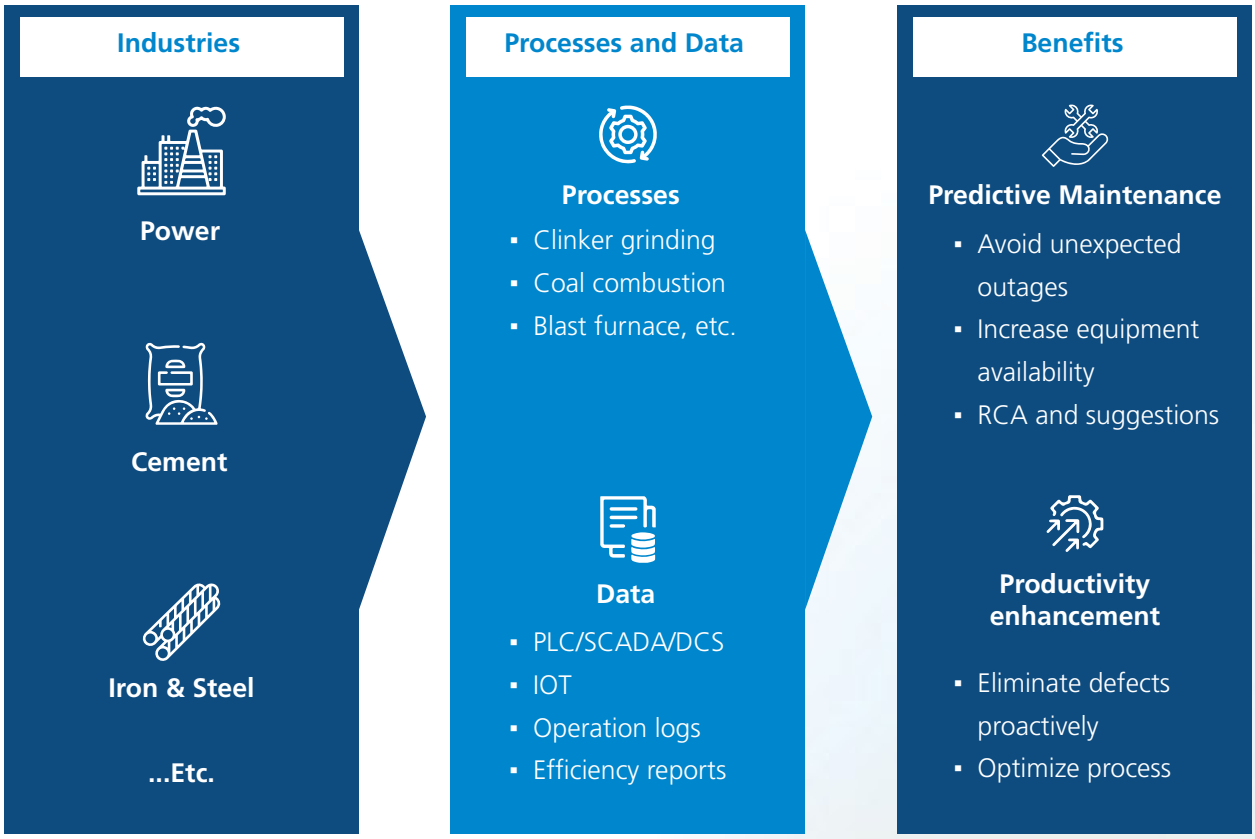

Figure 1: Gen AI in process manufacturing

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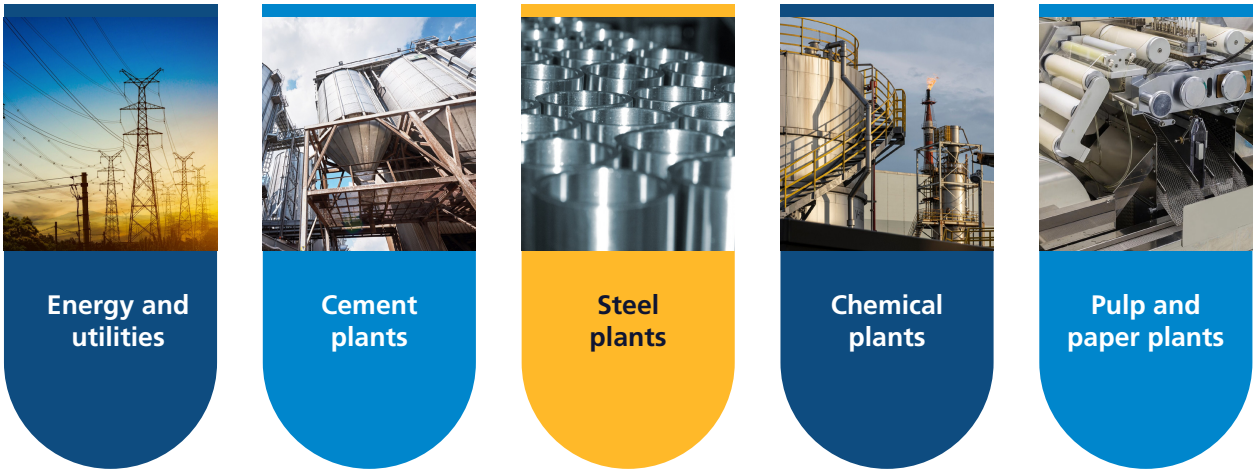
Predictive maintenance (PdM)

Typically, O&M teams in process industries maintain shift logs consisting of parameter values, equipment status, fault logs and efficiency parameters. Unlike IOT data, which is refreshed in real-time or near real-time basis, this shift data is captured shift wise. From a text mining or Natural Language Processing (NLP) perspective, this is a gold mine of data and can be used to derive meaningful and actionable insights akin to a PdM system. A generative AI system constructed using these data sets can serve many purposes.

Firstly, it can suggest when maintenance of a piece of equipment is really required (maintenance on demand vs regular preventive maintenance). Sticking to conventional preventive maintenance may create a scenario of over maintenance or under maintenance of equipment. This can lead to unnecessary costs or unexpected equipment breakdowns, respectively.

Secondly, it can predict when a particular piece of equipment is going to fail, thus alerting the operations team. Generative AI can create synthetic data by learning from past data and trends, do RCA, FMEA and finally generate the predictions to fulfil predictive maintenance. It can also provide recommended suggestions.

Some of the industries most suited to Gen AI-driven PdM are:



Productivity enhancement

Gen AI can identify patterns in production data that can be used to improve productivity, lower cost, and improve efficiency. Generative AI can improve product quality by analyzing sensor data from machines to discover patterns in the process flow, indicating possible defects in products. This can help manufacturers identify and fix problems and eliminate defects before products are shipped to customers, reducing the risk of recalls, and improving customer satisfaction.

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Discrete part manufacturing

In a typical assembly line, tools such as CAD and CAM are used to create and simulate designs, create prototypes, and do conformity tests. If the test is passed, the part is ready for mass production. But if it fails, the design process must be repeated from scratch. This not only wastes time but also may lead to designer fatigue. In many cases a designer must not only think from rigidity or strength of the part but also must keep a frugal angle, meaning he must optimize the material going into the part without compromising on the integrity, so that material cost can be saved. These are a few important dimensions which must be managed in discrete part manufacturing. Generative AI can learn from the design process, talk to the design tools, and ensure optimized parts in the design process. It can learn the variations and ensure better results every time. Moreover, it is not prone to fatigue. It can enable rapid prototyping and mass production in assembly lines where large number of different parts are manufactured every day.

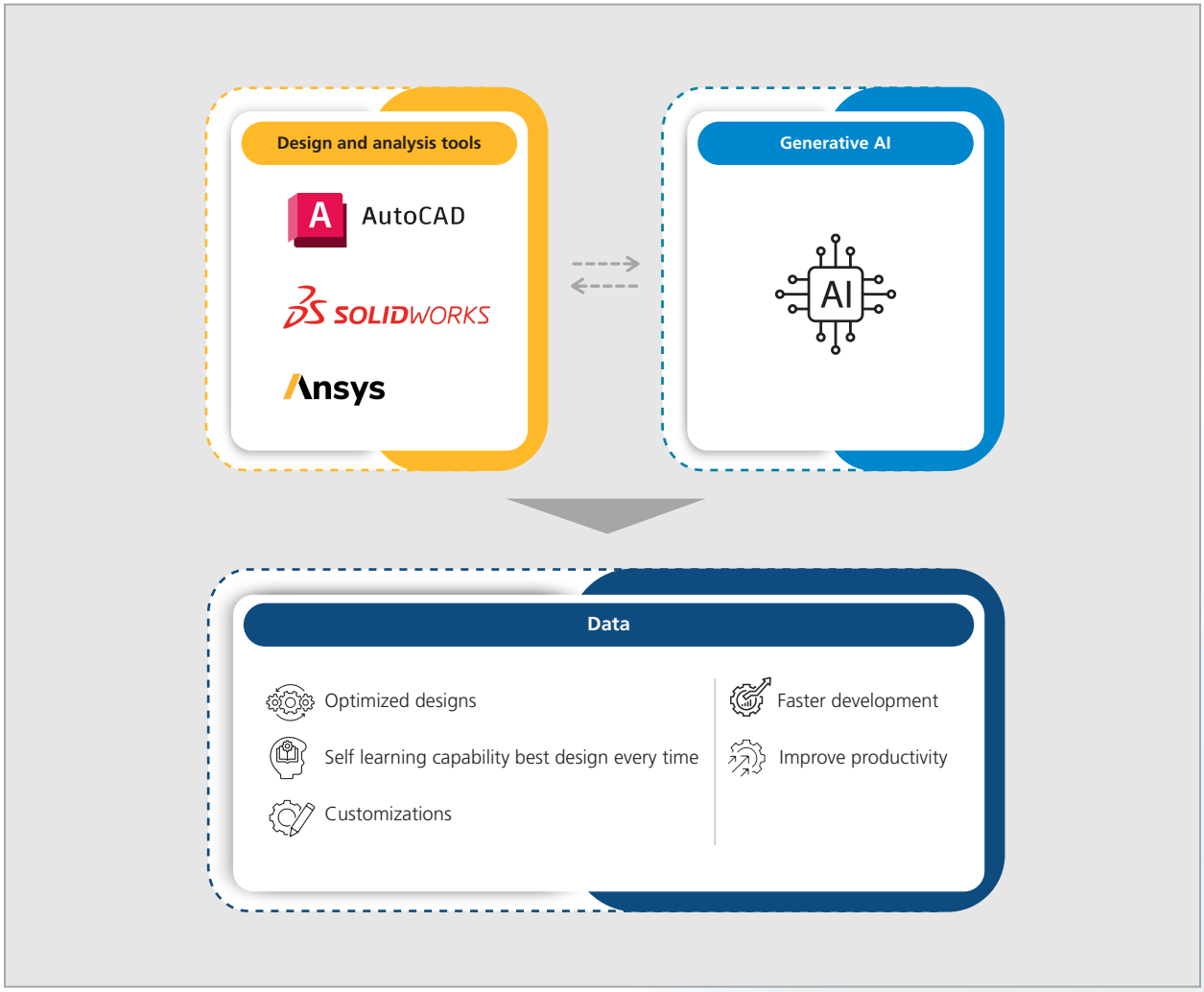

Figure 2: Gen AI in discrete part manufacturing

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Rapid prototyping

Generative AI design can be broadly utilized in manufacturing industries like aerospace and automotive. It can help in designing complex parts and components. Manufacturers utilize iterative design methodology to optimize their designs based on factors like weight, strength, and specific requirements. Generative AI can learn from the patterns and reduce the number of iterations, thus reducing the design cycle. Moreover, it can prove to be invaluable for creating customized products and enabling rapid prototyping. By harnessing generative AI design, manufacturers can achieve better efficiency, reduced turnaround time (TAT), cost-effectiveness, and innovation in their products. It can empower designers to create sophisticated, tailored solutions to meet diverse industry demands.

Efficiency improvement

In a typical manufacturing assembly line generative AI can be used to predict the best routes for movement of raw materials, semi-finished components or robots, identifying the most efficient way to move and manipulate materials which can help reduce accidents and avoid manufacturing faulty items. In this way, Gen AI can help adopt a lean philosophy in the true sense and improve process efficiency and productivity.

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Quality assurance

Computer vision has been enhancing manufacturing processes and improving worker safety for the last few years. By using high-resolution cameras and AI algorithms, computer vision can identify defects and anomalies that may go unnoticed by human observation. For instance, when a part moves from station A to station B, it can have very microscopic dents which can go unnoticed by the human eye but could later lead to a faulty product. This allows for quick intervention, reducing waste and recall rates, while maintaining the original meaning of the text. Generative AI can be trained on the various defects and identify the faults that arise from them. Gen AI can also help monitor the work environment, promptly detecting potential hazards like gas leaks, or alerting workers to take necessary precautions to prevent accidents. A few safety cases can be a worker moving under a suspended load, a worker not wearing protective gear, etc. By integrating computer vision technology with Gen AI, manufacturers can improve efficiency, quality control, and worker safety, enabling a safe and productive manufacturing setup.

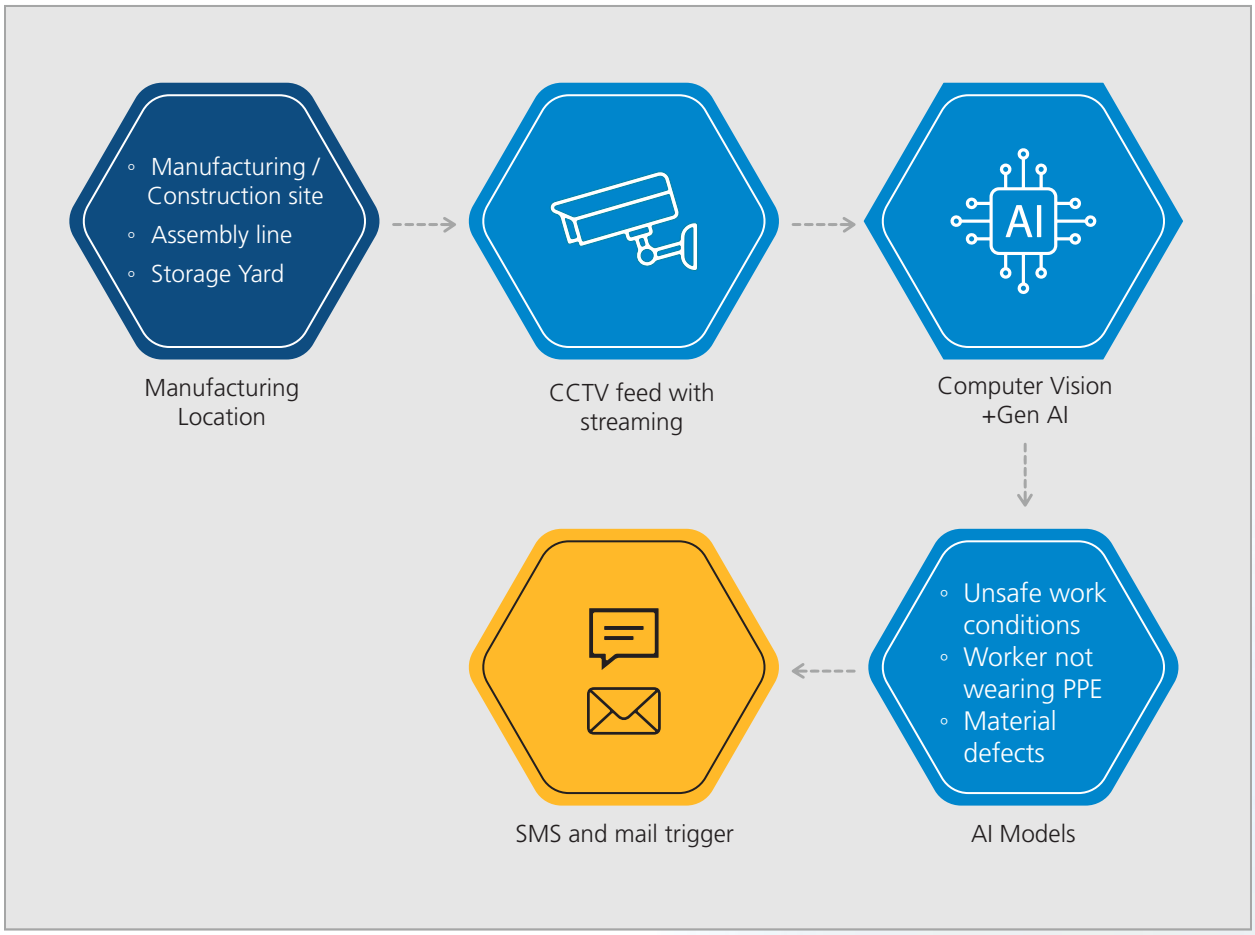

Figure 3: Gen AI in QC

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Optimal vendor selection

Gen AI can be trained on procurement data which consists of a list of vendors with details of their performance in terms of delivery time, price, and quality. Based on this, it can support the procurement team in optimal vendor selection. Gen AI can efficiently and effectively consolidate procurement data, enhancing supply chain visibility and control.

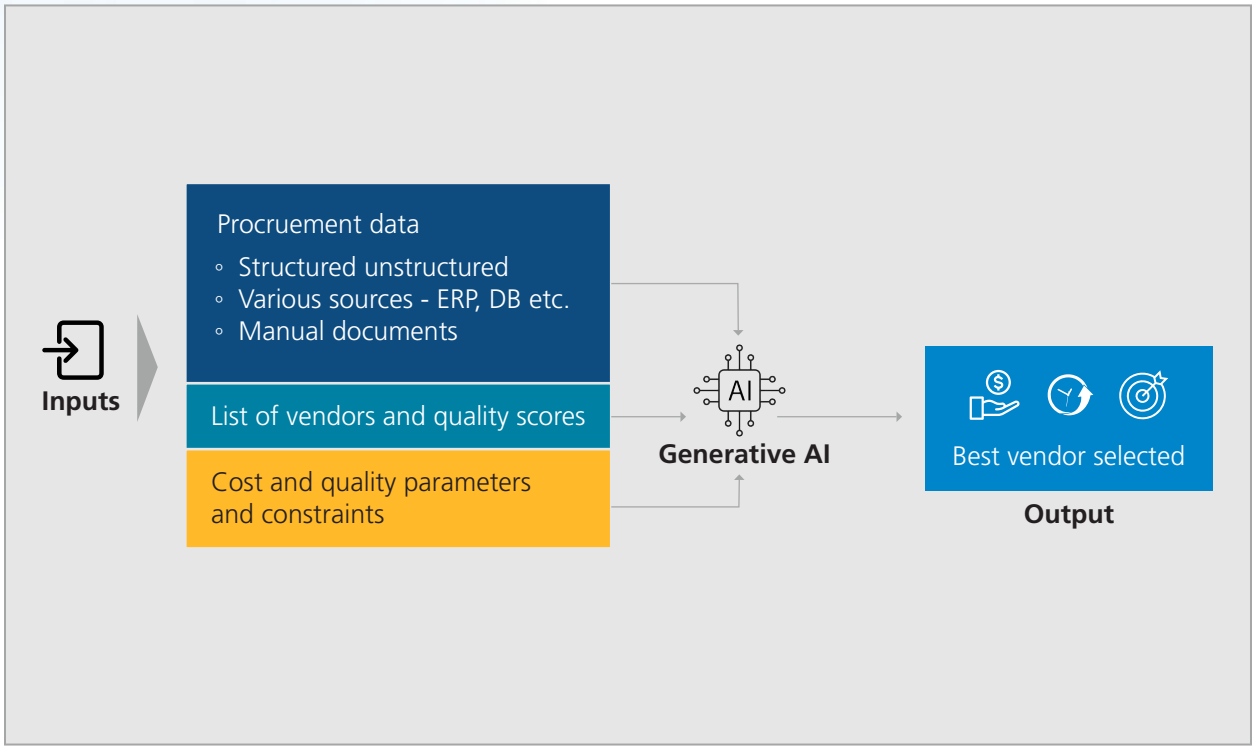

Figure 4: Gen AI in optimal vendor selection

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Conclusion

Today, Gen AI as a subset of AI is in its nascent stage, and only the tip of the iceberg is visible. However, its potential to bring massive disruptions across processes and industries cannot be discounted. It is likely to be the next big thing after Industry 4.0. In certain promising areas such as content creation and chatbots, Gen AI is already delivering substantial impact. However, the manufacturing sector is yet to realize the full potential of Gen AI in its entirety. It will be exciting to see how its enormous capabilities are explored and mapped with promising use cases in manufacturing, some of which have been explored in this paper, thus delivering great value to stakeholders in the near future.

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Abhishek Sarma is an experienced project and product manager with 12+ years of experience in digital transformation. He has expertise in creating and delivering AI/ML products and solutions in optimization, predictive analytics, and sustainability. The author comes with a strong background in R&D and power and utilities. He is a keen technology enthusiast with an interest in AI/ML, Gen AI, and Industry 4.0

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