Whitepaper

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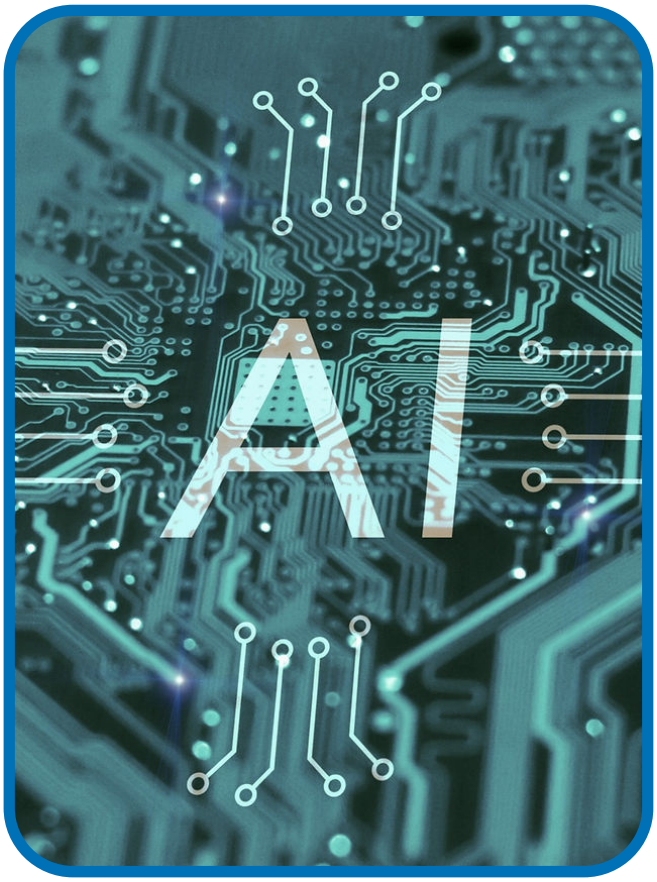
How Artificial Intelligence is Changing Manufacturing

Data and Analytics Can Drive Improvement in the Manufacturing Process

> **"It's okay to have your eggs in one basket as long as you control what happens to that basket."**
>
> **- Elon Musk**

Leaders in this highly competitive global manufacturing environment are constantly looking for new technology and methods of improving operations, which is achieved by controlling quality and manufacturing processes. You can either buy new machinery and equipment to improve automation, train your team on lean methodology, or build on traditional well known tools like statistical process control (SPC) or six sigma. Innovation in computing technology offers different alternatives that allow you to achieve a higher level of control in your manufacturing environment, using data and analytics. Startups like Tesla, are using these advancements, which allowed them to deliver 1.5 Million Electric Vehicles (EV) in the year 2022 (Pham, 2020).

Innovation in Artificial Intelligence (or data driven analytics) is propelled forward by revolution in retail. This technology which ranges from offline to e-commerce, has accelerated since the beginning of the pandemic. It allows you to aggregate data from your machines, along with quality and enterprise systems and also grants you the ability to analyze that data automatically to take control over your manufacturing processes and generate high quality products. AI and data can supplement your manufacturing process and quality teams, in order to focus on customer experience and process innovation. It does this while delegating repetitive mundane analysis work to computing systems. AI systems using machine learning technology can continuously absorb new information from the high and lows in production outcomes, and change based on what was learned.



There may be concern about the resources required or the complexity of technology implementation. Actually, with the right AI platform for manufacturing, the possibility for early gain in 3-4 months and positive payback in one quarter will grow. This short white paper strives to bring the reader on an AI journey and show the potential of a new productivity frontier 1 enabled by AI and data built on many concepts used today in many manufacturing environments.

AI and analytics are revolutionizing performance in multiple industries

The number of companies adopting data and AI driven technology is increasing at an accelerating rate. Billion-dollar companies use AI to forecast profit and loss, which includes manufacturing. Many other industries, like sports, also use this technology. The NFL keeps track of statistics per game, team, and even individual player. This information can help the entire team improve over a season or game. Players can look at their performance and work on any weaknesses they have. Another thing that coaches and their teams learn is, the speed of the ball as it's passed and the players' locations on the field. You can find this information on the NFL's website.

An example of the information found on this site is that Jalen Reagor of the Philadelphia Eagles was number 11 on the list of fastest ball carriers for 2021's regular season. These companies use analytics written specifically for their needs to make the best decisions based on logistics, cap space, and availability. Algorithms that are based on past and current statistical analysis are created using this information. However, performance issues can occur, due to the age of the machinery used, or the experience of the operators.

Source: https://nextgenstats.nfl.com/

Data driven methods are not new: Statistical Process Control is used as one of the main tools in combating variation in manufacturing today

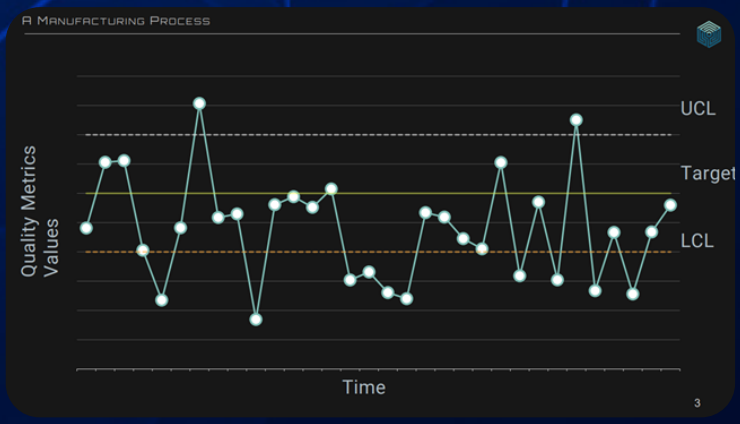
SPC stands for Statistical Process Control and is defined as "...the use of statistical techniques to control a process or production method(asq.org)." This method was invented in the 1920s, and the increasing adoption of calculators and computers (in 1980) in the mid 20th century, have enabled manufacturers to assert tighter control over quality and manufacturing processes. The fundamental principles of SPC are helpful in understanding how today's data driven technology works and how new advances can unlock more value for factory workers and operation teams.

SPC relies on measurement data taken from the manufacturing process using either manual entry or an automated data acquisition system. The key contribution of SPC to manufacturing as a concept is its focus on "variability" existing throughout the procedure. Statistical Process Control provides a toolbox of visual and qualitative tools to help in observing the variation and quantifying them. It relies on engineers' inquiry to understand the source of variability and take control in order to reduce it.

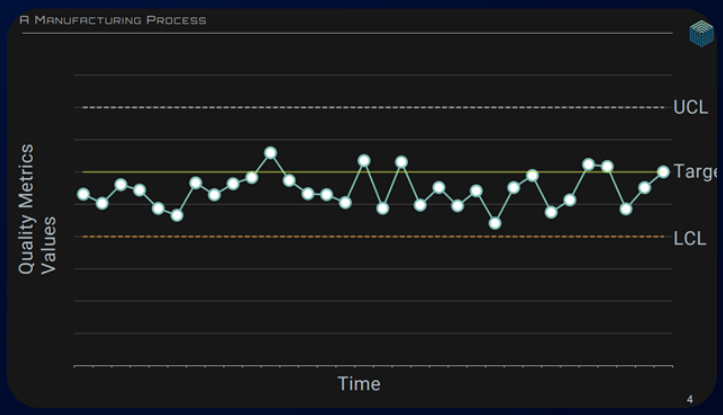
According to the American Society for Quality (ASQ), "variation is most often encountered as a change in data, expected outcomes, or production quality. Variation usually occurs in four separate areas…." The areas talked about by the ASQ are "1. Special causes 2. Common Causes 3. Tampering 4. Structural Variation." For example, a specific company's specifications for the size of extruded medical tubing could be a diameter of 0.1 inches and 0.03 in concentricity. When pulling some of the products off of the line to test and make sure that they are up to standards, some ended up being far off from the primary specification. SPC also includes quantitative measurements like Cpk to link sampled data to actual non-conformal part in the total production you have. If you are familiar with six sigma, the Cpk to the defect rate (in the unit of part per million (ppm)).

Cpk	Sigma	Defect Rate (ppm)
0.50	1.50	133,610
1.00	3.00	2,700
1.16	~3.50	465
1.33	4.00	64
1.50	4.50	7
1.60	~5.00	0.5
2.00	6.00	0.00198

Here is an example of a manufacturing process using a control chart



Manufacturing process with more variability

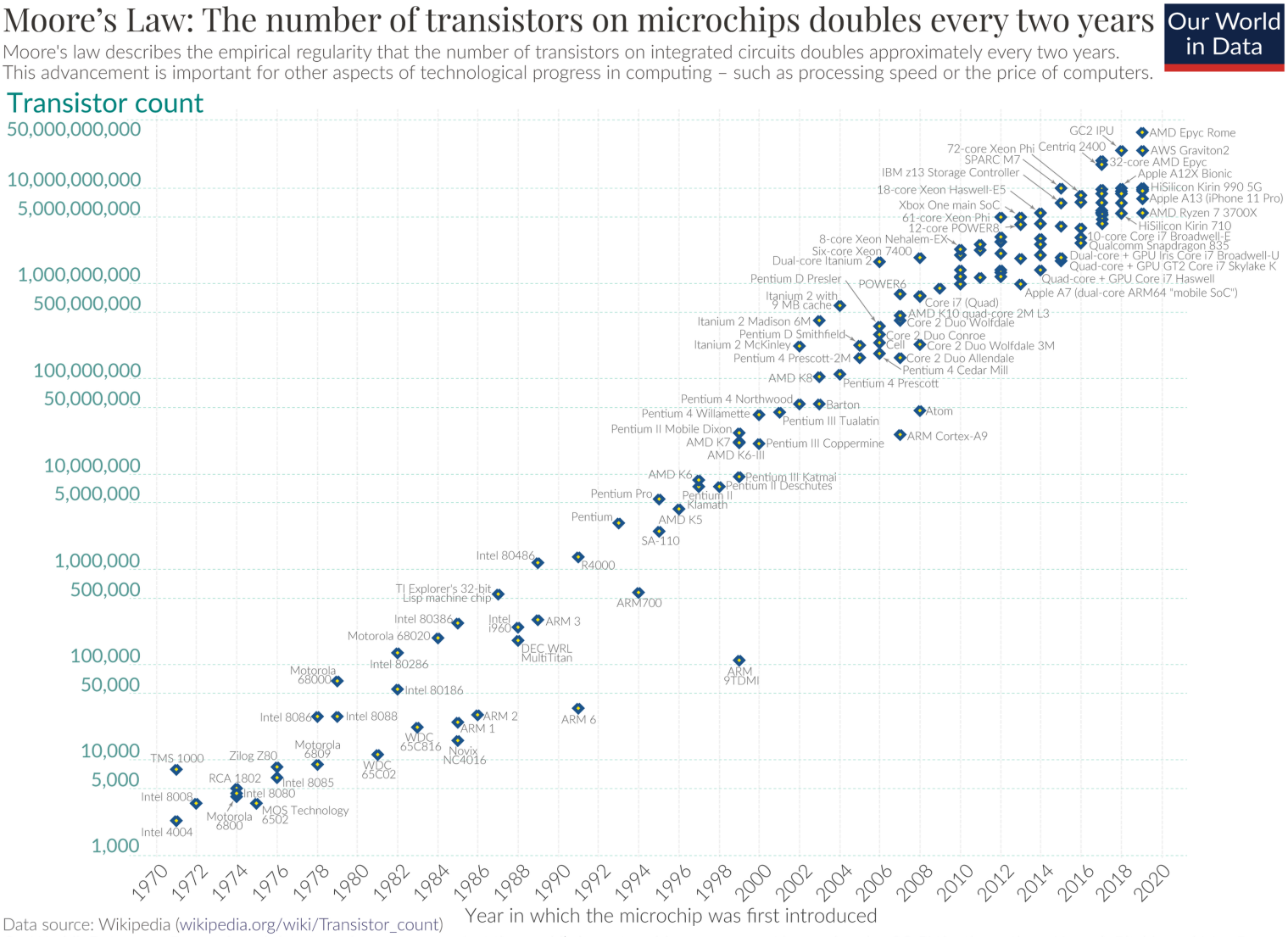


Manufacturing process after the variability is identified and under control

The methods of, x-bar and r charts help people identify what measurements are and are not in control. However, this tool doesn't solve the issue entirely. It only recognizes that a problem exists. In 1986, Bill Smith and Mikel Harry were accredited with having developed " Six Sigma." In 1995 Jack Welch made it the central business strategy of General Electric. While under their development, manufacturing operations used many other tools (fishbone diagrams, Pareto charts, etc.) for analysis. Again, no solution to the opportunity.

If you use SPC, your team may struggle to identify the source of the variability. An article from Accendo Reliability mentions several causes of variation and how a more stable process has minor variation caused by outside factors. A machine or human error can also cause variation. Depending on what is being manufactured, If the machine was programmed with the wrong 5 settings or someone in the factory uses the wrong ingredients or materials it won't go as planned. Going back to the example of the medical tubing, an external cause could be if the tubing was larger in length and width than the required size were caused by a mechanical problem rather than a pre-existing variation in materials

Manufacturing Quality Control and Performance Improvement in the Era of Big Data and Palm-sized Supercomputers.

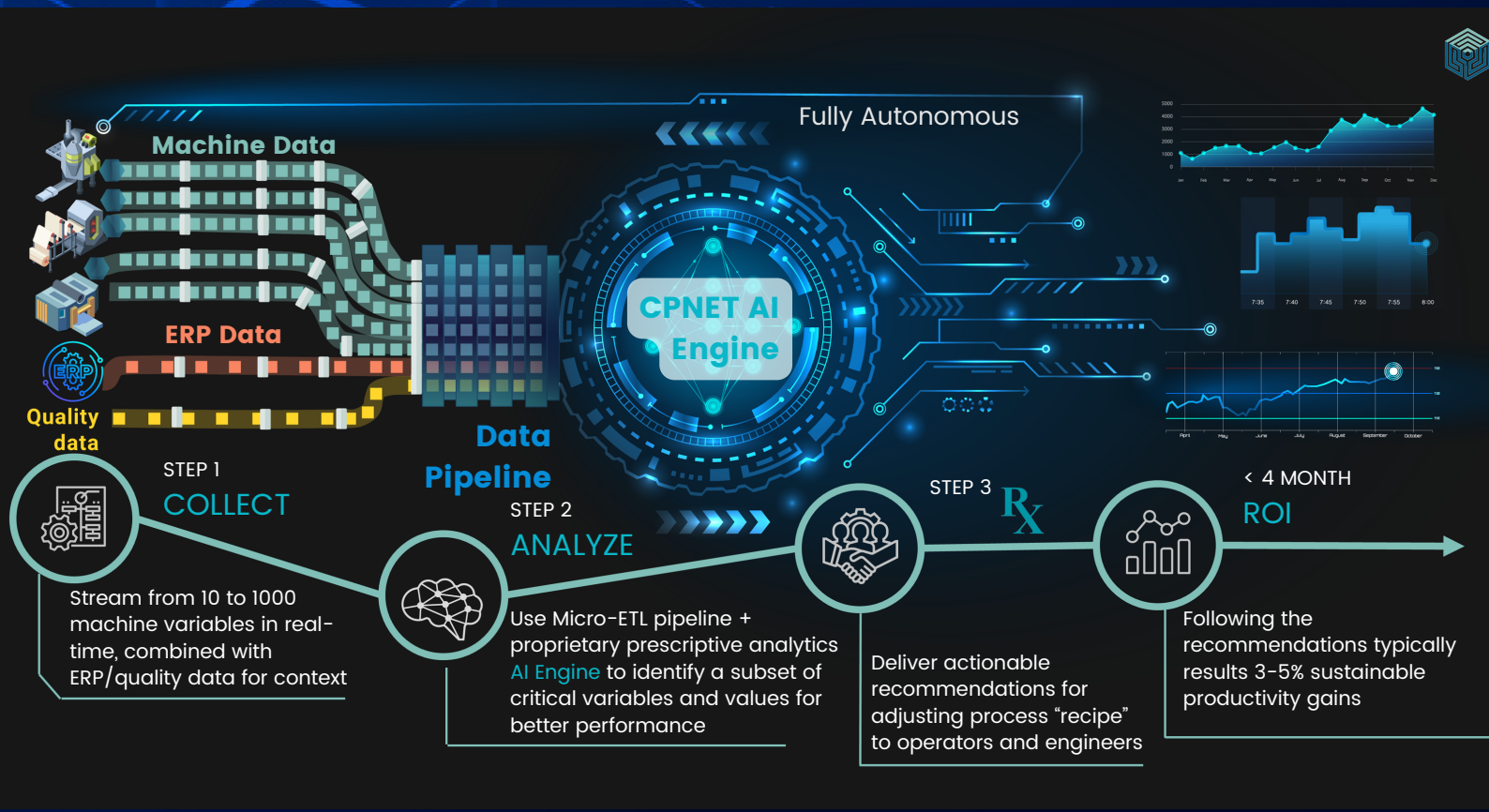


Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)
OurWorldinData.org – Research and data to make progress against the world's largest problems.

There are several ways that manufacturers can reduce variation. In a study done by Timothy M. Young Ph.D., he talks about his personal opinion on ways to reduce variation. Those ways include the workplace being open to new technology and methods of computing and analyzing data.

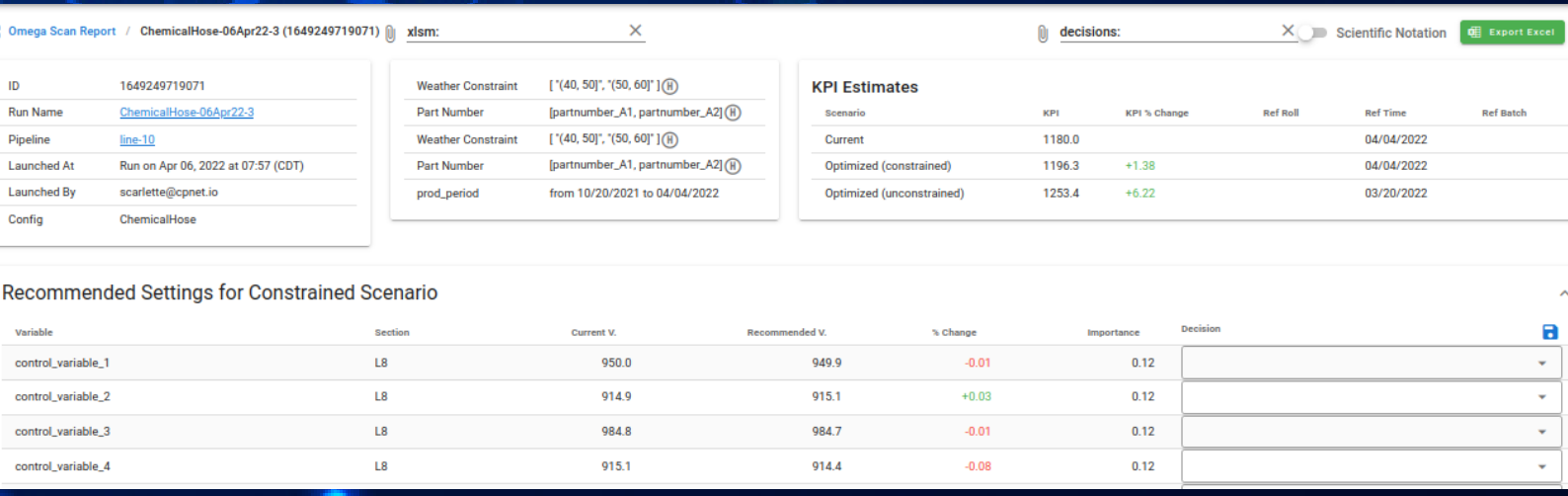
He talks about having a place to store the data and use it to improve and organize that data in charts and graphs to understand it better. Another point made in his study is understanding what causes variation in the specific factory in which products are made by conducting experiments and looking at data. Let's say that a machine malfunction causes a can's variation. The machine briefly stopped working correctly, and during that time, it caused the cans to vary in size. Understanding what and how that happened can help operators prevent the issue from occurring again in the future. Also, another way is to teach factory workers or anyone working with the machine to better understand the data and how machine learning works.

CPNET's AI Platform Can Elevate the Efficiency of a Production Process.



Also, another way is to teach factory workers or anyone working with the machine to better understand the data and how machine learning works. Another good idea, according to Young, is to determine the financial loss due to variation using mathematical equations. Although his study talks mainly about manufacturing using wood, manufacturers can apply these principles to any industry.

CPNet has worked with manufacturers in many different industries over the years. One particular company is in the plastic industry. They create containers, bottles, bags, cups, and more. Manufacturing companies installed our AI technology in one or more of their locations. Once installed, it keeps track of their process and identifies any low points. These points are then considered when offering suggestions on ways to improve. You may be wondering how plastic products are made. Heat is used to melt sheets of plastic into the desired shape. Imagine the plastic water bottle you recently drank from or the take-out container from the food you ordered the other night. Those are just some examples of what this company is proficient in creating. They could make more improvements, become more efficient, and become even more capable of creating their products.



Omega AI, created by CPNet, drives improvement in a factory's operating procedure and the overall process. An analysis done by this technology can help mitigate the adverse effects caused by variation. The machines themselves can make changes and adapt to them. Machine operators can also learn more about how to operate the machines if they weren't previously trained in machine learning. Learning more as a human being and machines being programmed to learn and change will improve the products and efficiency of the factory and process as a whole.

visit www.cpnet.io to find out more information if you're interested in using AI to improve quality.

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Resources

Fred Schenkelberg, Special and Common Causes of Process Variation,

https://accendoreliability.com/special-and-common-causes-of-process-variation/

Timothy M. Young Phd, Reducing Variation: The Role of Statistical Process Control in Advancing Product Quality,

https://www.engineeredwood.org/Data/Sites/3/documents/publications--news/techforum/REDUCING%20VARIATION.pdf

What is Statistical Process Control? SPC Quality Tools | ASQ

Pham, T. (2020, July 6). Data Analytics for Manufacturing: the Tesla's Case Study (Part 1). TGR International Blog.

https://blog.trginternational.com/data-analytics-for-manufacturing-the-tesla-motors-case-study