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# Digital Twin — The New age of Manufacturing



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## Introduction

With the rapid pace of technological growth, it's not always easy to imagine where digital transformation is taking the manufacturing sector, but one good way of doing this is to take a closer look at the “Digital Twin” concept within the industrial Internet of Things (IoT).

As IoT connectivity provides the manufacturing sector with an increasing number of ways to access sensor-driven data locked in industrial machines and equipment, the need for data analysis, management, and control methods has also become more crucial.

The amount of data collected from monitoring a smart factory is enormous, but if that data isn't aggregated and organized in a way that can support the decision-making process, then it's of no use.

One method that's proving to be invaluable to engineering and customer service teams that are looking to leverage collected data is that of the “Digital Twin”.

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## What is a Digital Twin?

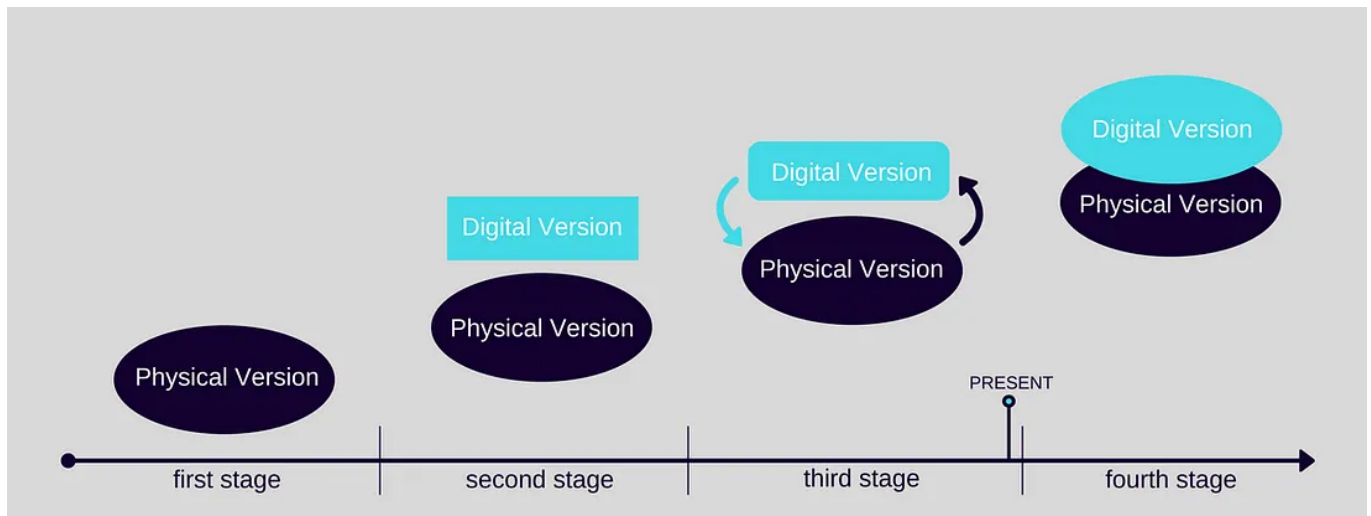
Digital Twin is a virtual representation that matches the physical attributes of a “real world” factory, plant, product or component in real time, through the use of sensors, cameras, and other data collection techniques.

In other words, Digital Twin is a live model that is used to drive business outcomes, and can be implemented in various ways within the manufacturing sector:

- Digital Twin of a specific asset within a facility
- Digital Twin of an entire facility
- Digital Twin of an individual product or component in the field

## The Emergence of Digital Twin in Industry

As with previous major turning points in the history of humankind such as the birth of agriculture and the industrial revolution, Digital Twin and industrial IoT represent a sea change in manufacturing.



The diagram above shows the four stages of the Digital Twin evolution:

First stage — The entire manufacturing process exists only as a physical version.

Second stage — A digital version is added which augments the physical version with additional information.

Third stage — An interaction begins between the physical and digital versions.

Fourth stage — There is further interaction and convergence between the physical and digital versions.

## The Digital Twin Concept

Since Digital Twin is essentially a tool, it can be applied in a seemingly limitless number of scenarios.

On a high level, industrial IoT Digital Twins allow us to:

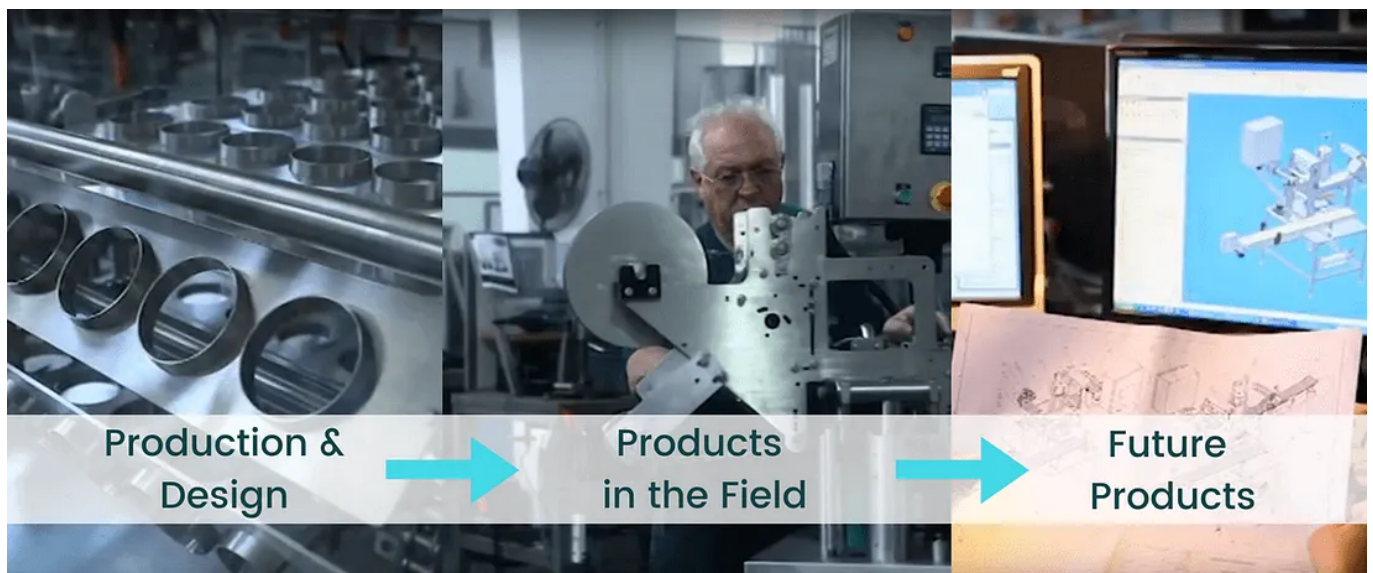
- Evaluate production decisions based upon analytics
- Visualize products performing in their environments or being used by actual people in real-time
- Commission machines from remote service centers, thereby reducing service costs
- Connect separate systems/processes for improved tracking and monitoring

- Troubleshoot equipment in remote locations to reduce incident resolution times
- Gain control over complex processes and systems-of-systems

## Impact Zones of Digital Twin on Manufacturing Business

What makes Digital Twin (and industrial IoT in general) so valuable is that it can provide value to businesses throughout the product manufacturing lifecycle.

The impact of Digital Twin technology can be categorized into 3 main “zones”:



### Impact Zone 1 — Production & Design

Industrial IoT Digital Twins optimize efficiency by predicting failures in production so that they can be fixed before they affect manufacturing targets. Improvements can be simulated by adjusting parameters along the production line in the twin without risking harm to production. Successful simulations can then be applied to the real-life system.

In addition, Digital Twins of products can be analyzed by engineering teams to compare the actual product behavior to its design. Behavior deviations can be assessed to influence future development iterations of the product.

### Impact Zone 2 — Products in the Field

Industrial IoT Digital Twins enable remote commissioning and diagnostics of products that are already in the field — lowering service costs, and improving customer satisfaction.

In cases where a technician is required to physically engage with the product in order to troubleshoot a malfunction, the problem can first be diagnosed remotely via the twin so that necessary equipment and parts can be ordered.

Similarly, when new products are to be commissioned for clients, configuration can be performed by service personnel remotely.

## **Impact Zone 3 — Future Products**

New products can be developed with insights based upon the behavior of existing products in the real world. Performance and customer usage are reflected in the twin, and then feed into the product development and manufacturing process to help boost product margins, and increase customer satisfaction and market share.

## **The 2 Major Advantages of Digital Twin Manufacturing**

### **Visualization**

Human learning and decision-making is enhanced through visualization, but with many of the advanced processes in manufacturing today, it's not always easy to get an accurate grasp of the factory floor and individual machine status. And when live data is presented to managers in the form of sheets of figures or basic charts, it can sometimes seem too abstract to form the basis for action.

Industrial IoT Digital Twin offers hybrid visualization, combining visual information with live and historical data. Managers can go under the hood of each and every machine to view physical parameters such as wear-and-tear and temperature abnormalities. Information that isn't critical can be hidden in order to prevent visual clutter, but can be recalled at any moment.

This level of visualization wasn't available before and significantly improves the ability to make informed decisions and to identify critical areas that need immediate attention.

### **Collaboration**

The visual aspect of Industrial IoT Digital Twins also lends itself to an improved level of collaboration. Physical distance from the real-world product/system no longer impedes stakeholders from being able to monitor

activity and weigh in. This connectivity means that alerts reach management immediately while human errors are mitigated by the removal of single points of failure.

Digital Twin gives access to a broader set of professionals than that provided by a shop floor. Data scientists, product managers and designers gain a much better understanding of the machines at work and the process as a whole. This leads to better design, and processes that are more efficient, saving time and resources, especially those involved in creating prototypes and testing them.

## **Product Line Engineering**

When the two advantages above merge, we get a very powerful engineering tool. Specifically, the Digital Twin approach lends itself very naturally to Product Line Engineering (PLE). In complex manufacturing operations, multiple iterations of a product are worked on by multiple teams. This can lead to confusion and human errors. Materials are often wasted as are hours of work.

With an industrial IoT Digital Twin, versions of the product or process can exist side-by-side. These versions can also be divided into iterations per department so that ideas can be tested against specific requirements.

PLE comes into play on the Industry 4.0 field in that it allows for an integrated approach to utilizing Digital Twin and making sure that there's a strong and fluid connection between the various phases of manufacturing.

## **Getting Started with Digital Twin Technology**

A Digital Twin helps manufacturers build better products, prevent malfunctions and errors, and predict outcomes that affect business, but what's the process for actually building one?

Let's start off with a useful tip: *the first version of any Digital Twin should be moderate in complexity.*

Too many sensors and an overwhelming amount of data will be too much to consolidate and will only add confusion to the decision-making process. On the other hand, leaving out critical alerts and not having enough data to produce useful analytics will prevent the twin from reaching its potential as

a powerful tool for engineers and managers.

When adopting new technology, it's important to follow a path that will be challenging, but not overbearing. The ROI needs to be short-term to provide momentum to the project and to make sure stakeholders stay on board and motivated.

Here's a general plan-of-attack for building a Digital Twin:



### **STEP 1 — Envision**

What is the most crucial insight that you would gain? In this first step, imagine situations where a Digital Twin would unlock value by either boosting efficiency or improving customer satisfaction. Focus on processes that are already providing value for the company, and validate concepts with a team that represents a variety of skill sets.

### **STEP 2 — Select**

Pick your pilot. Your first project should have the highest potential to reap rewards while also having a very good chance of being successfully carried out. An intricate twin of a very specific machine that will allow for deep analysis and monitoring might be a valuable tool with a high ROI, but as a pilot it might be too complex. Broader projects have the potential to scale across the organization, applying to different equipment and processes.

### **STEP 3 — Implement**

Make the pilot a reality and focus on your initial ROI objectives. An agile and iterative development strategy should be employed. Use a visual IoT modeling tool with simulation abilities to design the Digital Twin so that it replicates the behavior of the factory/asset/process.

The pilot you've selected should have a limited scope by focusing on a

specific part of the business, and must be able to demonstrate its value to the enterprise. It's important for management and team members to be focused, but open-minded enough to leverage new data collected during the process. As the first signs of success are measured, targets for more significant results should be set.

#### **STEP 4 — Industrialize**

The project's identity should be shifted from pilot to established tool. This should occur through improvements in performance, and the leverage of new twin-derived resources such as a data lake. Insights from the development and deployment process should be shared with other departments.

#### **STEP 5 — Scale**

Can you identify opportunities to scale the Digital Twin to realize a more complete industrial IoT platform? Limits originally set to control the scope of the twin should now be removed so that it can add value across the enterprise. Lessons learned and methodologies formed while producing the pilot should be used to improve the process.

#### **STEP 6 — Analyze**

The Digital Twin should be assessed against tangible IoT benefits such as improvements in yield, quality and efficiency, as well as cost reduction and prevention of issues. This analysis should provide a springboard for further tweaks to the twin, and its relationship with the enterprise.

In other words, Digital Twin is a dynamic tool, not a set-and-forget project.



### **Model-Based Systems Engineering for a Better Digital Twin**

For the initial development stages, and for continuous maintenance, Model-

Based Systems Engineering (MBSE) is one method that has been growing in popularity as a way to successfully deliver and manage Digital Twin and IoT projects in general.

Model-Based Systems Engineering is an established engineering discipline, which means it offers a defined pool of professionals with a specific skill set.

As a framework with its own principles and solutions, and because of its data-driven approach, Model-Based Systems Engineering could be extremely useful in successfully delivering a Digital Twin project.

## The Future of the Digital Twin Concept

The future of industrial IoT Digital Twins lies in how it will be utilized alongside other emerging technologies such as machine learning, object recognition, acoustic analytics, advanced signal processing and Natural Language Processing (NLP).

Digital Twin is already helping companies better meet the needs of their customers and quickly adapt to new demands from the market, and there's still a lot to discover.

Take the first step in your digital transformation by exploring how best-in-class tools can help you rapidly generate a Digital Twin for your enterprise or asset.

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