NTT DATA

Manufacturing × Digital Twin

Related Industries: Manufacturing, Automotive, Transportation & Logistics

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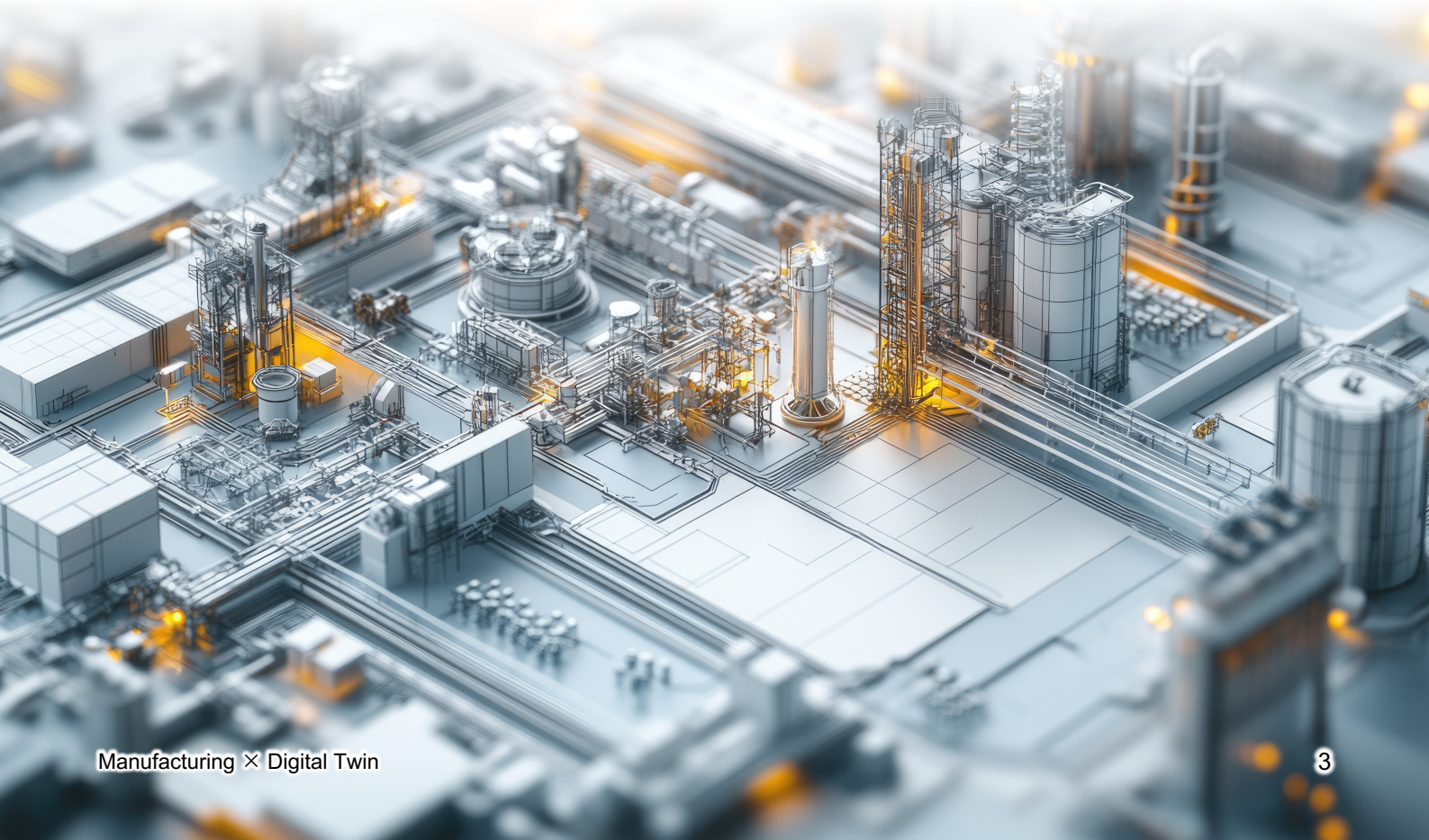
Chapter 1
Current Status of the Manufacturing Industry

In recent years, the environment surrounding the manufacturing industry has changed dramatically. While companies are under pressure to respond to changes in the industry and society, such as reforms in work styles as well as carbon neutrality and circular economy compliance, cyber attacks, supply chain disruptions due to political instability, and other risks are emerging. In addition, companies need to deal with the retirement of highly skilled workers and aging production facilities. The manufacturing industry is required to be prepared for these various uncertainties while strengthening its competitiveness.



1.1. Various Challenges in the Manufacturing Industry

In a drastically changing society, the manufacturing industry faces various challenges.

①Response to increasingly sophisticated customer needs

While meeting the demand for customization, production systems are required to be flexible and able to respond to quick changes. Also, product functions have to be upgradable to meet usage conditions even after purchase.

②Response to digitalized value chains

Value chains need to be upgraded through digitalization, such as by improving productivity, shortening the time from development to production start-up, and optimizing inter-company ordering, manufacturing, and logistic systems.

③Response to labor quality and quantity shortages

In some countries including Japan, labor shortages in the manufacturing sector are becoming increasingly serious. At the same time, decreases in the number of highly skilled workers are also major challenges.

④Response to sustainability

Responding to requests related to sustainability and circular economy is an increasing priority. Optimization of energy consumption and reduction of environmental impacts are urgently required.

⑤Response to risk management

Risks are diversifying and increasing in scale, including technology leaks and production line stoppages due to cyber attacks, supply chain vulnerabilities due to wars or policy changes in foreign countries, and demand fluctuations due to restrictions on export destinations.

1.2. Digital Twins Effective in Solving Problems

The digital twin is a technology that can be widely used to address a wide range of challenges the manufacturing industry is facing. This technology models various things in the physical world, including people, objects, and society, and digitizes them through real-time data collection and integration. It uses simulation-based forecasting of various scenarios to achieve optimal decision-making in view of efficiency, cost, and environmental impacts. This will enable companies to respond to various challenges, such as meeting customer needs with attention to detail, optimizing the value chain, addressing labor shortages, responding to the SDGs, and improving resilience. The use of digital twins has started in various fields ranging from NASA's space missions to manufacturing, city planning, finance, and healthcare. With advances in IoT, AI, and big data analytics, the scope of applications is rapidly expanding. On the other hand, the implementation of digital twins requires a comprehensive data strategy, rigorous security measures, a flexible IT infrastructure, interoperability among systems, and the development of specialized human resources. It is also important to optimize ROI by considering the balance between initial investment and long-term value creation.

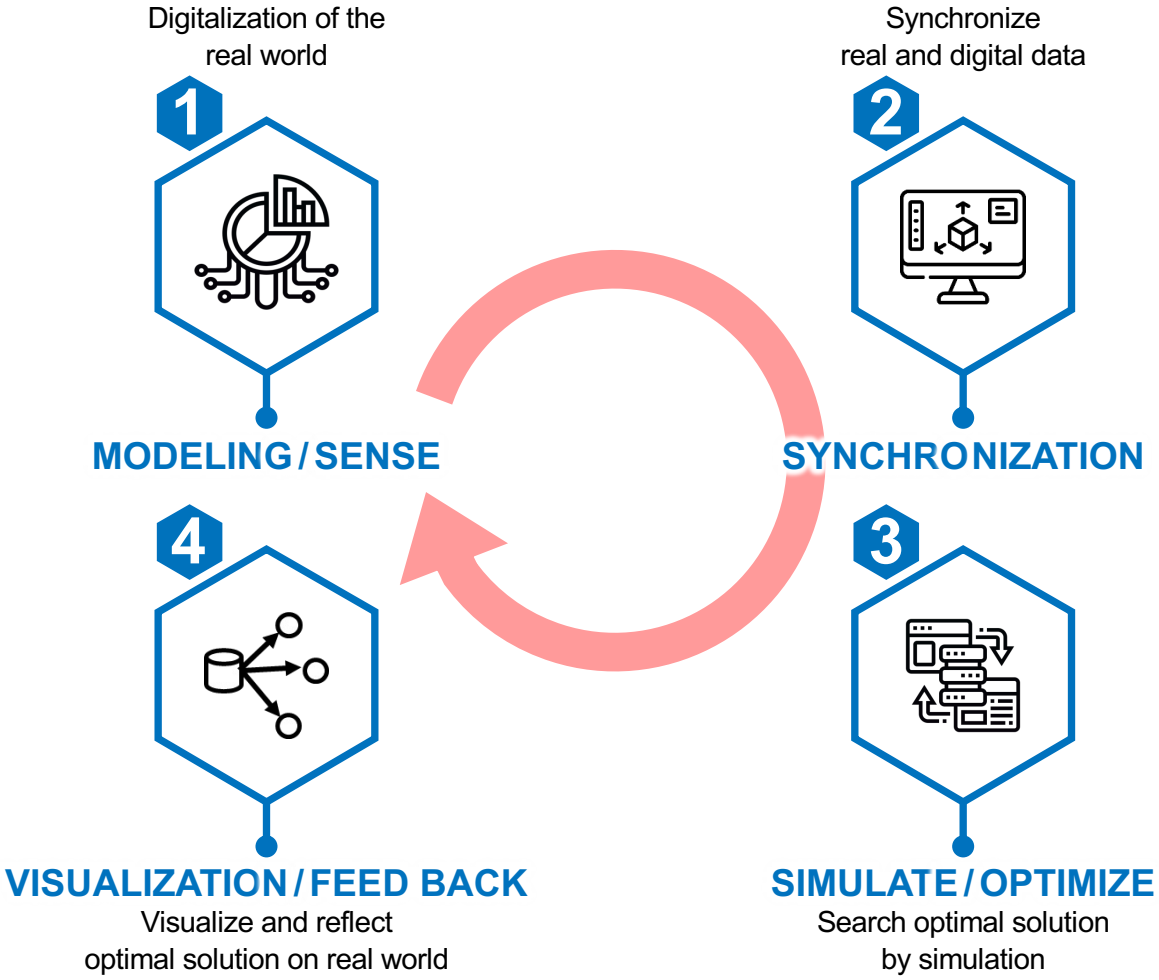
Chapter 2
The Future of Manufacturing Realized by Digital Twins

Digital twins digitize everything in the manufacturing industry, including various facilities, processes, people, parts, finished products, and many stakeholders in the supply chain, and reflect real-time status using various sensors. On this basis, simulations based on various scenarios are carried out, allowing companies to make optimal decisions through predictions of many parameters, such as productivity, supply and demand balance, and CO2 emissions. Digital twins are very effective strategic tools for comprehensively optimizing the entire processes in the manufacturing industry. NTT DATA is committed to contribute to the transformation of the entire manufacturing industry through digital twins.

2.1. Assets Required for Digital Twins

In the manufacturing industry, the use of digital twins is effective in a very large number of situations.

In order to build a digital twin, conversely, it is absolutely necessary to integrate various technologies, including (1) modeling of the real world, (2) data collection and synchronization, (3) simulation-based prediction and optimization, and (4) visualization and feedback to the physical world.



NTT DATA has developed a large number of combinatorial technology assets to quickly build up various kinds of digital twins in response to customer needs. In particular, for (1) modeling of the real world, we have 3D reconstruction technologies, such as photogrammetry and 3D Gaussian splatting, to build the real world as a 3D-modelled digital twin, and for (2) data collection and synchronization, we have systematic methodologies and know-how for efficiently managing large volumes of data, as well as the technology to synchronize point clouds acquired with different devices with high precision by aligning them and correcting offsets. For (3) simulation-based prediction and optimization, we not only have access to and create various simulators, but can also accelerate them using combinatorial optimization techniques and deep learning, including the use of quantum computers. For (4) visualization and feedback to the physical world, we have technologies such as building a digital twin in the metaverse that can be simultaneously experienced by multiple users in remote locations.

2.2. Use Cases for Digital Twins

In the manufacturing industry, digital twins can address many use cases.

✓ Optimizing production lines

Production lines are reproduced as digital twins, further synchronizing data in real time. Then, various scenarios are simulated to identify the optimal settings and processes. Digital twins can also be used for preventive maintenance of machines and production scheduling. These features are expected to reduce downtime, improve quality, maximize production efficiency, reduce human errors, and improve safety.

✓ Optimizing supply chains

The entire factory, warehouse, and transportation network is digitally twinned to synchronize real-time data. Then, the impacts of various situations, such as demand fluctuations and delays in parts delivery, are simulated. This enables the enterprise to identify the optimal inventory levels and transportation routes. Suppliers' production capacity is also visualized to predict procurement risks. These features allow the enterprise to reduce inventory cost, improve on-time delivery rates, respond to unexpected events quickly, optimizing its overall supply chain.

✓ Improving resilience

Companies can anticipate potential problems and obstacles, such as cyber attacks, wars and other international issues and the resulting supply chain disruptions, outage of critical infrastructure,
as well as policy changes in foreign countries, and develop countermeasures in advance. For example, companies can predict the impacts of external factors such as supply chain disruptions and raw material shortages based on various scenarios to minimize them, by taking measures such as securing appropriate inventories and diversifying suppliers. They can also predict fluctuations in demand under various scenarios and optimize production plans, reducing the risks of excess inventory due to customer diversification. The digital twin technology thus allows companies in the manufacturing industry to enhance resilience in many aspects, and strengthen the adaptability to changing market conditions.

Chapter 3
NTT DATA's Initiatives

NTT DATA has been working on the enterprise use of digital twins from an early stage, mainly at innovation centers in Italy and Germany. The two examples shown below are typical digital twin use cases in the manufacturing industry. In addition to these existing use cases, we plan to propose use cases in which related technologies such as smart robots and production plan optimization are combined, and promote their implementation in Japan and other parts of the world.

3.1. Digital Twin-Based Robot Arm Control※1

We reproduced a manufacturing station using robot arms from FANUC Deutschland GmbH in a digital twin and provided it to our customer. Applying the computer vision technology to the cameras, the system captures real-world information such as the position and orientation of objects picked up by the robots, and reflects the data on the digital twin side. This identifies the position, orientation, color, and shape of the objects, allowing the motion of the robot arms to be simulated in the digital twin. The manipulation commands corresponding to the simulation results are then transmitted to the robots. This system uses high-capacity connectivity technologies including private 5G and edge computing to create a digital twin that can perform various processing in real time, such as capturing a massive amount of sensor data and image data, and providing feedback control to a large amount of in-factory equipment.

3.2. Digital Twin-Based Optimization of Automotive Parts Logistics※2

In collaboration with Telefónica Tech, we developed a proof of concept of a digital twin-based logistic platform of transporting finished parts to its warehouse for CIE Automotive, a Spanish automotive parts manufacturer.

This solution is a digital twin including automatic guided vehicles and programmable logic controllers from various providers, an ERP system to control enterprise resources, and sensors to identify door openings, products, and cases. This digital twin optimizes task scheduling for the entire manufacturing process and provides real-time and intuitive monitoring of the status of various devices and sensors.

Using this digital twin, CIE Automotive can collect and analyze data in real time to improve efficiency and respond to changes more rapidly, which is also expected to contribute to the safety and health of the staff.

※1 https://www.nttdata.com/global/en/news/press-release/2023/october/to-create-a-digital-twin-of-robotic-arms-for-industrial-digitalization-use-cases

※2 https://benelux.nttdata.com/insights/case-studies/evolving-internal-logistics-operations-5g

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