Digital Twins

A digital twin is a virtual copy of a real asset, such as a machine, a building or a process, that is kept up to date with live data. The idea is commonly credited to Michael Grieves, who presented it around 2002 in the field of product lifecycle management. The name was popularised later, notably in a NASA technology roadmap in 2010. Today, factories, utilities and cities use twins to watch operations and to plan maintenance. We can understand them through four parts: what a twin is, how it works, and how it helps operations and maintenance.

1. What a Digital Twin Is

A digital twin is more than a drawing, because it stays connected to the real asset. Researchers often separate three levels, depending on how data moves. In a digital model, people move data by hand. In a digital shadow, data flows automatically from the real asset to the copy, and in a digital twin, information can flow back too. So the key question is always whether live data keeps the copy up to date.

Example: A traffic app shows a live copy of a city's roads. Applying What a Digital Twin Is, we ask whether live data keeps it up to date: phone data does, so the app shows today's jam, not an old map.

At work: Karim, a plant manager, has a three-dimensional drawing of a pump. Applying What a Digital Twin Is, he asks whether live data updates it: it does not, so it is only a digital model. Once sensor readings update it automatically, it becomes a digital shadow.

2. How It Works

A digital twin works as a loop. Sensors collect data about the real asset, such as temperature or vibration, and send it over a network to a platform. A model there uses the data to mirror the asset's current state and to run simulations. The results go to people on dashboards or, in some systems, back to the asset as new settings. The ISO 23247 standards describe a framework for twins in manufacturing, covering what to copy, such as machines, materials and people, and how data is exchanged.

Example: A smart thermostat shows part of this loop. Applying How It Works, a sensor reads the room, the app shows it, and a new setting changes the heating.

At work: Karim fits vibration and temperature sensors to the pump. Applying How It Works, the data goes to a platform, the model mirrors the pump's state, and a dashboard shows it to the team.

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3. Use in Operations

In operations, a twin gives a live view of how assets and processes are performing. It also allows what-if tests: we change a setting in the copy and watch the result, with no risk to the real asset. These tests help to find bottlenecks, save energy and plan changes. The twin supports decisions, but people still decide.

Example: A driver tests two routes in a map app before leaving. Applying Use in Operations, a what-if test in the copy shows which route is quicker, with no risk.

At work: Karim wants to run the packing line ten percent faster. Applying Use in Operations, he tests it in the line's twin first. The copy shows a queue at the labelling machine, so he fixes it before changing the real line.

4. Use in Maintenance

In maintenance, a twin compares live data with normal behaviour. Early signs of wear, such as rising vibration, can appear before a breakdown. This supports predictive maintenance: we repair when the data suggests it is needed, at a convenient time. A twin is only as good as its data and its model. Sensors cost money and connected systems need security, so it is wise to start with one valuable asset.

Example: A car dashboard warns that a tyre is losing pressure before it goes flat. Applying Use in Maintenance, live data compared with normal values gives an early warning.

At work: Karim's pump twin shows vibration rising above normal. Applying Use in Maintenance, he books a bearing replacement for the next planned stop. The pump does not fail during production.

Conclusion

In summary, a digital twin is a virtual copy of a real asset that stays up to date through live data. Sensors, a data link and a model form a loop that can show the present and test the future. In operations, it supports monitoring and what-if tests, and in maintenance it helps to spot problems early. Because a twin depends on good data, it is best to start small, with one asset and one clear question.

Sources

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