From a simulation model to a digital twin

Definitions, applications and success factors

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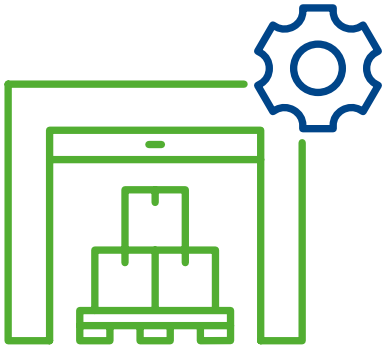
While the term ‘digital twin’ tends to be widely used and abused nowadays, there are still very few examples of the concept itself being put into practice. What most people refer to as a ‘digital twin’ is often actually nothing more than a simulation model like the ones we have been using for years. So what is a digital twin exactly? Dirk Becks (from Groenewout) and Dirk-Jan Moens and Steven Hamoen (both from Talumis) explain what exactly a digital twin is and what to be aware of when setting up a digital twin.



First of all, it is important to note that a digital twin is not the same as a digital model or a digital shadow. What they have in common is that they all revolve around a digital object that is an exact replica of a physical object such as a system, process or complete warehouse, and the digital object can be used to conduct analysis based on data from the physical object. The key difference between a digital model or digital shadow and a digital twin lies in how the data is input into the digital object and how the results of the analysis are used to control the physical object.

Digital model

The simplest variant is a digital model based on manual data entry. In a digital model of a warehouse, for example, entering an overview of the expected number of orders for tomorrow will reveal potential bottlenecks in the warehouse and how many operatives will be needed to avoid those bottlenecks. It may be possible to model extra scenarios. For example, what if there are 10% or 20% more orders than expected? Based on the resulting insights, planners can decide whether extra or fewer operatives will be required. Users of a digital model have to execute their decisions manually.

Digital shadow

A digital shadow goes a step further. In this case, the data is input automatically rather than manually thanks to the digital object being connected to the warehouse management system (WMS), Enterprise Resource Planning (ERP) or to a central database storing the data from various systems. The digital shadow offers a continuous view of what is happening in the warehouse and provides insight into the performance and trends. By pressing 'fast-forward', it is possible to forecast the future to some extent. Once again, however, the decisions made on the basis of the digital shadow must be executed manually.

Digital twin

The term 'digital twin' applies if the results from the digital object are automatically linked back to the physical object, making it possible to control and fine-tune processes. An example of this could be a digital twin that continuously monitors whether the order picking process is running according to plan, and which automatically deploys extra order pickers if it determines that the end-of-day deadline is otherwise unlikely to be met. There are few, if any, applications like this in warehousing right now. Therefore, most of the current use cases that are referred to as digital twins are actually digital shadows or digital models.

People or computers?

As indicated in the examples given above, we can use digital objects to predict tomorrow's workload or to analyze the impact of potential decisions. The digital object visualizes the consequences of decisions so that users can make carefully considered choices about whether or not to implement those decisions in practice. The key question is whether companies are willing to use a digital twin for that purpose. Many businesses prefer to let people rather than computers make such decisions. In that case, a digital shadow is enough.

Example: allocating goods

A possible application relates to goods allocation. If a slow-moving item becomes a fast-mover, it can make sense to move that item to a different pick location. While a modern WMS will signal that and make a suggestion, the suggestion is based solely on the inventory turnover. In contrast, a digital object additionally takes account of things like walking and driving distances inside the warehouse, congestion in the aisles and the complexity of the order picking process. These factors are used to precisely calculate whether the benefits of increased order picking efficiency outweigh the costs of moving the item.

Start by defining the problem

So if you want to set up a digital shadow or digital twin, where should you start? To find the answer, you need to ask yourself another question: which problem do you want to solve, and what is the best approach? For example, if you just want to calculate how many people you need tomorrow, a number of formulas in a spreadsheet program may suffice. A digital shadow goes a step further, such as by taking peaks in the daily workload into account, but takes more time – and therefore money – to set up.

Determine the right level of detail

We advise against setting up a digital shadow in order to identify the problems. If you want to investigate everything without missing a single operational bottleneck, you will need to build a digital object with a very high level of detail – and a higher level of detail means more effort and higher costs. If you already know which problem you want to tackle, you also know which level of detail is required.

Build the digital object

The next step is to start building the digital object. This requires data – not only about the layout of the warehouse, but also about the traffic management plan, for example. Think about the movement of vehicles around the warehouse; will there be one-way or two-way traffic? Information is also needed about the amount of time involved in processes. How long does it take to walk or drive from Location A to Location B? And how long does it take to pick an order line? Needless to say, some operatives work faster than others. This can lead to deviations, which is why it is important to validate the digital object before use.

Feed with live data

The digital shadow or digital twin then has to be fed with live data, such as from the WMS or ERP system, for example, but this could also come from systems for workforce planning, maintenance planning, transport planning, dock planning and so on. In addition, you may wish to utilize historical data for information about seasonal patterns and suchlike.

Success factor: master data

The quality of the digital object and of the data used as input is an important success factor. That starts with ensuring that the master data is accurate and complete and that it is entered into the digital object correctly so that all the pieces fall into place. The same holds true for information about how long processes take, for example. If the picking time is entered as 12 seconds per order when the actual picking time is only 10 seconds, the difference may seem negligible. However, in the case of 50,000 orders per day, the difference can amount to 100,000 seconds (i.e., almost 28 hours). Reliable processing times are essential for accurate forecasting and planning.

Serious approach

Last but not least, just as with any digitalization project, it is important to take the implementation of a digital shadow or digital twin seriously and to be honest with yourself. In some cases, it may become apparent that the company is not yet ready for this type of digitalization, perhaps due to issues with data availability or data quality. In others, the digital shadow or digital twin may be so complex that it is difficult to extract the right insights as the basis for making the right decisions. Therefore, ensure that your digital object is as straightforward and user-friendly as possible. If you don't, there is a strong chance that no one will end up using it.

Better and cheaper

The use of digital shadows – and especially of digital twins – in warehousing is still fairly limited at the moment, but that will definitely change in the future. First and foremost, the technology is becoming better and cheaper, which means that a digital object can be set up more quickly and easily. Additionally, most companies are making strong progress in terms of digitalization, so the quality and availability of data is also improving. Multiple applications of digital shadows and digital twins are already emerging in other, more complex environments. Now that mechanization and robotization are increasing the complexity of warehousing, we can expect them to take off in this sector too.

More digital objects

In logistics, two other terms regularly crop up: emulation and visualization. Both these terms refer to solutions that also revolve around a digital object. We mention them here for reasons of completeness, but we have chosen not to cover them in the article itself.

Emulation

With emulation a digital object is utilized to test control software. Rather than being connected to a real conveyor, a PLC is connected to a digital representation of the conveyor to test whether the control software processes all the signals correctly and whether all the logic has been programmed properly.

Visualization

Visualization refers to a technology that is used in the control room of an automated warehouse, for example, to display the status of all systems. In effect, this makes use of a digital shadow, but without any kind of link back to the physical object.

Emulation

Visualization

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For complex simulations, Groenewout works together with Talumis. Talumis utilizes Flexsim simulation software to build models that form the basis for further analysis and optimization activities.

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