DIGITAL TWIN
The technology trend for Industrie 4.0

Dr. Thomas Kuhn, Head of the Embedded Systems Division at Fraunhofer IESE, is convinced of the idea of the "digital twin".

In 2017, Gartner [1] considered the concept of the digital twin one of the 10 most important strategic technology trends. What exactly it means and which crucial role it can play in the business network of the future is explained by Dr. Thomas Kuhn, Head of the Embedded Systems Division at Fraunhofer IESE.

What is the definition of a digital twin? How did this idea even come about?

A digital twin is the digital image of things from the real world. It describes both physical objects and non-physical things, e.g., services. In principle, the digital twin is a software unit that behaves exactly like the real system – all relevant properties of the real system are present. The term first appeared at NASA. Back in 2012 already, its scientists proposed the digital twin as a solution for reducing the escalating costs for certification and tests. Since tests with airplanes and rockets are very expensive, the idea emerged to do these with the help of digital twins.

How good a digital twin is depends on how good its simulation model is, i.e., how many properties of the real system it can reflect with which degree of accuracy.

The digital twin is mostly found in the context of Industrie 4.0. How can this idea be transferred to the manufacturing industry?

The manufacturing industry is the most prominent application domain. Here, digital twins are a tool for enabling flexible production for Industrie 4.0. The digital twins are a virtual image of a real machine or plant. In other words, they form a bridge between the real and the digital world and have all the functions and services that their real models can provide and execute. In addition, the respective virtual representations continually collect data about the current state of the plant components. If all the digital twins are combined, they become a comprehensive image of the production environment, resp. the plant.

Which benefit can an organization gain from the use of digital twins? Do you have any examples?

One advantage is that "What-if" analyses can be performed, meaning specific alternatives can be tested, e.g., in production planning, without having to shut down the existing plant. Another benefit is virtual integration or commissioning: With the digital twin it can be determined whether a new part of the plant is compatible with an existing part.

Most of the time, certain adaptations will be necessary, of course. Whether a machine with these adaptations will be compatible with the existing machine can then be tested virtually. Of course, this also applies to the replacement, addition, or removal of components. The great advantage is that virtual testing allows a huge reduction of standstill times, meaning the plant can run productively much faster. Modifications in production are thus becoming much more flexible. And this is where the circle closes again to Industrie 4.0.

In your Industrie 4.0 project BaSys 4.0, digital twins also play a central role. What are their tasks here?

In our research project BaSys 4.0, which is funded by the German Federal Ministry of Education and Research (BMBF), we and 14 other partners from the area of production technology are jointly developing concepts and solutions for the realization of digital twins as digital representations for production. Our focus is on the implementation of a cross-site and cross-network, safe, and self-organizing communication interface that manages self-describing data objects. In our project, we equate the terms digital twins and administrative asset shell. For as soon as the administrative asset shell has a unit that can simulate a device, we can call it a digital twin. The administrative asset shell contains the data structure encompassing everything that is important for the device, such as data sheet, operating instructions, or real-time data such as device condition, services, etc.

In BaSys 4.0, the administrative asset shell takes over the job of general communication interface. It tells me which service I have to call to move a conveyor belt forward or backward, for example. However, BaSys services can also be used without a simulation model.

In April, the Hannover Messe trade fair is coming up for you. Which demonstrator will you use there to show the use of digital twins?

We will go to the trade fair with a demonstrator of our research project BaSys 4.0, which combines the virtual world with the real world. With the help of an interactive table and the model of a production line, we will simulate an Industrie 4.0 production plant into which we have integrated BaSys 4.0 as the middleware. We will allow our visitors to experience changeable production by letting them play different roles. Depending on whether they will act as a production worker, a production manager, or a plant operator, they will be able to execute different scenarios live, such as integrating new machines. In their active roles, the visitors will learn about the abstract concepts of administrative asset shells, resp. digital twins, service-based production, and middleware – right in the middle of Industrie 4.0. A visit will definitely be worth it.

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More on the trend topic Digital Twin:

[1] http://www.gartner.com/smarterwithgartner/garTners-top-10-technology-trends-2017/