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Digital companion from planning to maintenance

THE ERA OF THE TWINS

The digital transformation towards Industry 4.0 is gaining a powerful competitor in the form of the digital twin. Insiders like VTU expert Herbert Andert are already raving about the fantastic possibilities for use.

By Andreas Aichinger

The digital twin, defined as the digital representation of a real object, is currently one of the hottest trends in the digital transformation. This formerly futuristic fantasy is flourishing on every corner, has taken hold of large parts of the industry and hardly stops at any sector. Even the leisure and entertainment industries have by now adopted the digital twin – well, quadruplets, to be precise: Only recently, the legendary pop group ABBA caused quite a stir with their plan to have elaborately programmed virtual avatars stand in for them at future stage concerts. But actually, the stages for twin-music have been set in other fields long ago. Digital twin applications can already be found today in production, plant engineering or even in the construction industry under the related concept of building information modelling (BIM). But what is really behind the trendy buzzword "digital twin"?

The parents of the twin

Herbert Andert has known the twin since its childhood, so to speak. And the Division Manager for Automation & Industrial Digitalisation at the plant manufacturer VTU Engineering therefore also knows that the twin has actually long since matured into a fine adult, and is not – as the young trend term suggests – an immature baby made of bits and bytes. Andert: "The digital twin has basically been given a new name; however, many elements of the concept have been around since the 1990s. For example, I myself digitally simulated a huge transport facility almost 20 years ago."

What has become the digital twin today would have been called a "simulation" or "mathematical model" in the past, says the automation engineer. So is this old wine in new bottles? Not at all. Everything that makes up the digital twin works "better, more conveniently and faster" today, the VTU expert knows. However, those who consider simulations and mathematical models to be the "parents" of the digital twin are not entirely wrong. In addition to continuously improved computing power and sensor technology, we have a lot more data now from the field level thanks to the Internet of Things (IoT), Andert argues. And more vividly put: "In the past, you would read a value on a sight glass. Today, you can adjust control parameters to optimally set a plant to the operating point."

Twin detects compressor fault

Herbert Andert has many vivid examples of the concrete benefits of a digital twin. For example, a company in the plastics processing industry once had a problem with a large compressor unit that kept failing without any apparent cause. And when even the manufacturer's expert was stumped, VTU Engineering and the digital twin swooped in to save the day. "Our first task was to find the process-relevant parameters," Andert tells us. Out of 150 measured values – each of which did not show any deviations – 30 were selected, and the respective series of measurements were finally mathematically analyzed and reconstructed. Andert: "In the end, we had a mathematical formula for every measured value, an algorithm, ultimately a mathematical mirror image of the process." When this mathematical twin model is fed with data, the parameter relevant to the case of damage soon crystallizes: In this case it was the process pressure.

Herbert Andert, Division Manager
Automation and Industrial Digitalisation
VTU Engineering GmbH

VTU expert Herbert Andert is convinced that a digital twin has what it takes to generate added value from the management level to the shop floor.

"Only through this mathematical analysis and through this digital twin were we able to find the relevant parameter" – and also make accurate predictions for the future based on the model created. The digital twin thus also becomes a door opener for an increasingly important topic: Predictive maintenance, the proactive maintenance of systems including optimized use of wear parts. After all: "You get information about wear and tear and you don't have to throw anything away that hasn't been completely used up."

The optimal operating point

In fact, the field of possible digital twin applications is extremely broad. In contrast to the usual definitions, the one used at VTU takes precisely this breadth into account. According to this definition, a "digital model of the plants or plant components required by the customer" from the planning phase through commissioning to the operating phase is intended to represent a kind of playground for finding the optimum for the respective phase through trials and testing.

At the very beginning of the chain and even before the actual planning, are process simulations. These include, for instance, digital tests of the mass flow in order to be able to assess at an early stage whether a plant can meet expectations at all. "This is the first test that shows whether the investment is worthwhile," Andert emphasizes.

The engineering phase is primarily concerned with identifying design errors, while the operating phase focuses on finding the optimum operating point for a plant. Andert sees the latter as the most economically significant application, also because – as in the compressor example – deviations from the ideal quality can be corrected at an early stage. Moreover: "With such a mathematical model, you can optimize your production with regard to efficiency, production speed, material consumption or minimum output, for example." This will be highly relevant for the pharmaceutical industry in the coming era of personalized medicine, for example, in order to adjust multipurpose plants to frequently changing active ingredient contents in customized medicines.

From the factory to the valve

The possibility of optimizing the active ingredient concentration of a pharmaceutical product with the help of a digital twin is already being discussed. The VTU expert tells us of a customer who was able to save valuable active ingredient by preventing admixtures beyond the required minimum. The direct result was an increase in turnover of a whopping 200,000 euros, Andert proudly tells us. Digital twin applications that revolve around a mathematical model ("data driven model") are consequently labelled "mathematical twin" at VTU. In contrast to that, "conventional" simulation based on physical models of the plant is necessary for operator training, for example. The dynamic simulation of an entire plant for training new personnel or testing error scenarios represents "another milestone" for Herbert Andert. But you can start small, also as a digital twin, for example as a smart 3D image for virtual reality and augmented reality applications.

Indeed, dynamic 3D models have been a standard at VTU since a major think tank on industrial digitalization two years ago. A control valve, for example, now contains the part number, manufacturer, visualization address, dimensions and maintenance information and can be used again and again as part of a library. Each component is thus represented by its own digital twin.

Added value & environmental protection

The VTU manager is convinced that a digital twin has what it takes to generate added value from the management level to the shop floor. "With a digital twin, decisions around reinvestment needs or conversion plans can be tested for their effects at every level and optimized or abandoned as necessary," says Andert. Also: "There is hardly a production plant where no useful application for a digital twin can be found."

But Andert also thinks of the bigger picture and sees positive effects on people and the environment as well: "Through the virtual mirroring of machines, plants and even entire factories, we can plan and operate them in such a way that we can reduce resource and energy consumption as well as pollutants to a minimum." At the end, Andert, who patiently explains the new possibilities to anyone interested, has one last message burning on his lips: “What we're doing is just great.”

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- Herbert Andert

About the company

The VTU group develops and plans process systems engineering for industry. The range of services stretches from plant optimization to general planning of large investments. The focus is on the pharmaceuticals, biotechnology and chemicals industries.

Customers include well-known corporations such as Novartis, Evonik or Boehringer Ingelheim. The company was founded in 1990 as a one-man engineering office in Graz. More than 900 employees are currently working on projects all over the world. The 28 sites are spread across six European countries – Austria, Germany, Switzerland, Italy, Poland and Romania.