WE SOLVE PROBLEMS DIRECTLY WHERE THEY ARISE

HOW A DIGITAL COPY OF A GEARWHEEL EMERGES FROM ITS "COMPONENT DNA"

1

Winner placement at the „Industry 4.0 Award"

2

Reduce complexity with big data

3

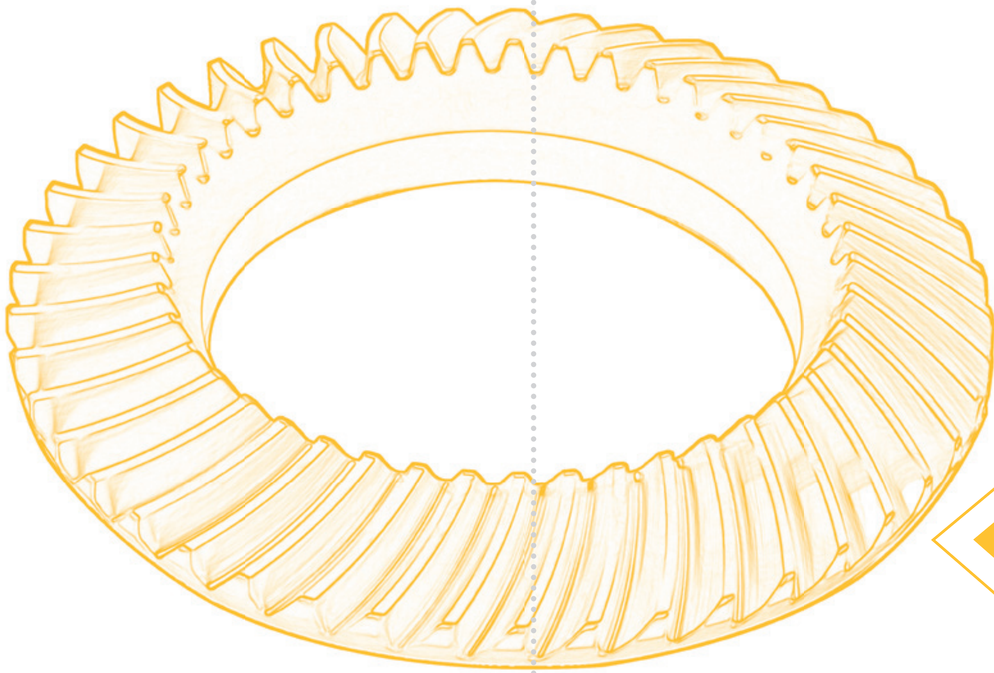
Incorporate and motivate employees

Interview with Dr. Hartmuth Müller, Head of Technology and Innovation at Klingelnberg GmbH

Dr. Müller, your company won the "Industry 4.0 Award" with a digital twin implementation in gearwheel production. What's so special about your solution?

1

The simple underlying idea. We wanted to create a complete, digital copy of the actual physical manufacturing world – in this case, gearwheel production. When you imagine a gearwheel, you think of a certain number of teeth and flank shapes – and it ought to be completely sufficient to describe the geometry in order to create a "copy". This, however, is not the case, as **a gearwheel has "inner values"** that depend on the material, such as compressive residual stresses or hardness profiles. We used all this information – the "DNA" of the component so to speak – to create a digital replica that can be accessed at the press of a button anywhere along the production process chain.



What advantages did you hope to gain from this and how has your production process changed?

A major advantage emerged, for example, in the area of quality control. Prior to digitization, this process step was also carried out by us following a simple model at the end of gearwheel production. If the gearwheel worked, you were happy; if the state of the contacts was poor, you weren't happy, and you had to "repair" the wheel set. The fact that our gearwheel twin has been implemented from end to end means that we have defined a specific, individual geometry for every process step. We therefore learn immediately when something goes wrong with that process step and are able to intervene to correct the problem straightaway.

2

The same applies when setting up the gear-cutting tools. Since the geometry of a bar blade cutter head is available in digital form, a comparison with the actual tool geometry and a superordinate closed-loop enables a high-precision gear-cutting tool to be set up for machining. **The efficiency gain can be found in the high first-pass yield,** in other words, the extremely small number of defective components and in reliable set-up and machining processes. This automatic "closed-loop assistance system" has given us a production process that runs very smoothly without interruption. We therefore no longer repair after the fact; instead, we solve problems directly where they arise.

It nevertheless sounds like a huge amount of data to handle – how do you ensure that the "digital twin" doesn't end up pushing complexity?

3

With our big data approach: We only collect data that help us better understand the process. Hardening gearwheels always leads to distortions. Using analytical methods, we tried to create a causal chain in order to calculate the hardening distortions. However, this couldn't be done, and so we decided instead to use correlation as an approach to solving the problem. We collect geometric variations that arise in hardening processes and use them to create a knowledge base. This allows us to predict with relative certainty how a particular component with a certain geometry will behave in the hardening process. This, in turn, permits us to calculate a minimum but safe machining allowance. This is how we create the optimum conditions for subsequent process steps during hard-fine machining.

What tasks does the GearEngine IT platform perform in yourclosed-loop production system?

4

This is where several services converge: GearEngine manages the gearwheel data and all production resource data, and **ensures traceability over the manufacturing process for every single gearwheel** – provided they can be identified using a DMC code or RFID chip. As soon as a gearwheel is identified in the process chain for the first time, GearEngine creates a digital component file for it. Each machine involved in the process reports the previously defined parameters for the gearwheel currently being processed back to the platform. This is how the actual component and the digital file evolve over the value chain. Networking the processing machines and the gearwheel calculation software with the GearEngine platform permits the data to be made available directly to each machine involved at all times. The IT platform also monitors the current state of wear of all production resources.

What challeng should production companies always keep an eye on when developing and introducing a digital twin?

5

The biggest challenge is getting employees properly involved in the project at the very beginning: if the team doesn't fully back the project, it well never succeed. For example, when we were developing the support system that I just mentioned, a number of employees were concerned that their expertise would be incorporated into the software and thus make their job superfluous – this was definitely not the case. In this instance, you have to put a lot of effort into convincing employees that the software can't do a thing without their knowledge, and that it will remain this way in future. We succeeded in doing this. The digital twin not only enjoys a high level of acceptance among employees, but we have also been able to leverage the aforementioned benefits from the word go.

>> We only collect data that help us better understand the process

The mechanical engineering company Klingelnberg GmbH is the global market and technology leader in the development and manufacture of machines for the production of gearwheels, precision measuring centers for axially symmetrical objects of all types, and of high-precision gear components made to customers' orders.
With around 1,300 employees – of whom 220 are R&D engineers – around the globe and more than 100 patents, the company consistently demonstrates its capacity for innovation. Today, Klingelnberg operates engineering and manufacturing facilities in Zurich, Switzerland, Hückeswagen and Ettlingen, Germany, and Györ, Hungary. The company maintains a global presence with sales and service offices for customers and partners from a range of industries including the automotive, commercial vehicle and aircraft industries, shipbuilding, the wind-power industry, and general gear manufacturing.

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