

# 200 years of the bicycle—computer scientists electrify historic 'dandy horse'

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Professor Holger Hermanns riding the Dandy Horse, in the background Florian Schiessl, on the right the Belgian bicycle engineer Dries Callebaut. Credit: Oliver Dietze

In honor of the inventor, their prototype is still made completely of

wood, but it also contains an electric motor, battery, sensors and mini-computer. As soon as the rider pushes off from the ground, the motor starts and provides additional power during the entire ride. With their "Draisine 200.0" the computer scientists are testing the validity of mathematical proofs, among other things to improve the safety of e-bike software.

Holger Hermanns is a professor of computer science at Saarland University and has also become well-known in the bicycling scene. With his basic research, he wants to help the fast-growing e-bike industry avoid programming errors that have already become the subject of headlines in other industries. Hermanns is convinced that "if we succeed in making automatic software verification an industry standard, we will no longer have to go through things like the diesel scandal."

In 2011 he presented a wireless bicycle brake. He proved the reliability of the radio-based brake through mathematical methods, which are also used in the control systems of aircraft or chemical plants. The wireless bicycle brake thus made worldwide headlines. In 2016 he was awarded by the European Research Council with a 2.4 million euro Advanced Grant. With this grant, Holger Hermanns seeks to advance e-bike software in the area of operational safety. A few weeks later, Hermanns learned that June 12, 2017 would be the 200th anniversary of the first bicycle tour. He decided to replicate Drais' dandy horse, this time equipped with an electric drive.

Together with Dries Callebaut, a Belgian bicycle engineer, in a few months he developed a prototype for the "Draisine 200.0". To honor Karl von Drais, the follow-on model is built completely of wood and is braked using a sort of foot pedal on the wooden front wheel. In the center of the wooden back wheel is a 200W electric motor, driven by a 750g battery. Through a cable, the electric motor is connected to a mini-computer, which sits on the frame and controls the motor with the help

of a speed sensor. However, this in particular has proven to be difficult.

"With conventional electric bikes, the motor turns on when the pedals move, but the dandy horse does not have these," explains Hermanns. Therefore, working out exactly when the rider is pushing the dandy horse is a challenge, making the fine-tuning of the developed control software nerve-racking. The researchers quickly realized that small errors could have potentially catastrophic results. "Imagine that you jump over a curb, the sensors interpret this as pushing and the [electric motor](#) speeds up to its 25 km/h top speed," Hermanns explains. The members of his group, above all Gereon Fox and Florian Schiessl, are continuing to test the prototypes. They have even mounted a camera on the frame, to provide video evidence for the correct interplay of human and electric power. To synchronize the video recordings with the measured sensor data, they developed a special LED clock that is read automatically.

Their efforts have paid off: the third prototype - with mini-computer, battery and speed sensor now hidden completely inside the wood frame - is no longer affected by strong vibrations. For Professor Hermanns' research group, this is, however, only the beginning: "We will now verify the correctness of the software, i.e., mathematically prove that the [motor](#) will not run faster than the allowed top speed and the battery will not be overloaded," explains Hermanns. Now, however, the computer science professor wants to take a longer test drive on the current prototype. This is ultimately how it all began 200 years ago.

**More information:** [www.powver.org/draisine-200-0/](http://www.powver.org/draisine-200-0/)

Provided by Saarland University

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