The Netherlands' most intelligent cycle path

How innovations are making cycling even more sustainable and attractive

Mobility Innovation Centre Delft

Do IoT
Innovation in Internet of Things
Fieldlab

The Netherlands' most intelligent cycle path

Just in front of the entrance of TU Delft's Faculty of Civil Engineering and Geosciences, there's a very special stretch of cycle path. This 'circular' strip, 25 m in length, is equipped with a comprehensive monitoring system (both above and underground). The cycling-related data this produces will provide researchers and developers with new knowledge and insights that can improve the design of our bicycle networks and achieve even smarter ways of managing cycle traffic.

Cycling is already a 'green' way of getting around. But, on TU Delft Campus, we are demonstrating that the *infrastructure* can also be sustainable: a new section of the Campus' cycle path is made from recycled plastic. Because the plastic panels are not solid, this cycle path can also be used to store water, for example during heavy rainfall. As a result, this innovative infrastructure is not only circular—it also contributes to climate adaptation!

But there's another reason why this 25 m stretch of cycle path is of interest to scientists and developers: it's equipped with a wide-ranging set of sensors—both above and below ground—that monitor the weather, the condition of the road surface, and cycle traffic 24 hours a day. In such a unique setting, we can rightly say that this piece of infrastructure is *the Netherlands' most intelligent cycle path*.

Research

Using the monitoring data produced by the cycle path, we can learn a lot about the current traffic situation. Thanks to the pressure sensors and 3D cameras, we know exactly how many cyclists pass by, their direction of travel, their speed, and their manoeuvres: braking, swerving, overtaking, etc. It's even possible to tell the difference between a bike, an e-bike, and a scooter.

But scientists at TU Delft are working hard to obtain more information from the data. For example, what is the situation with regard to *traffic safety*? Does the mix of different modes of transport on the cycle path cause problems? What can we learn from the 'near-accidents' observed? How is the safety situation affected by sudden rainfall?

Various studies are also being conducted aimed at using the measurement data for *forecasting*. Can we use artificial intelligence to predict the traffic situation fifteen minutes, an hour, or even longer in advance? Similarly, how can we use these forecasts to make (bicycle) traffic management *proactive*?

Sharing data

The sensor data produced by the intelligent cycle path can also serve as excellent input for other platforms. If shared with public lighting systems, for example, the data can enable intelligent lighting, activating only when cyclists are actually passing by.

Traffic regulation systems are another example. They can use the measurement data to show a green signal for cyclists, taking account of their number, speed, and the prevailing weather ('more green lights when it's raining'). Research at TU Delft shows that this could reduce the average number of cyclists' stops at traffic lights by 65 percent!

To make these applications possible, the monitoring system will be equipped with rapid and reliable *5G communication* in 2023.

Roll-out

Reliable and accurate monitoring of bicycle movements can prove hugely helpful in providing better support to cyclists and making cycling more attractive. At the same time, we can use information about safety on the cycle path to improve the bicycle network and the design of the cycle path itself. However, it will be necessary to take measurements at more places than just on TU Delft Campus. This potential roll-out is already being factored into our research: what will we need to measure (and where) in order to gain a sufficiently reliable and comprehensive picture of bicycle flows on a network?

Photo: Rick Wink

Guaranteed privacy

The monitoring system on the intelligence cycle path has been designed with privacy and data security in mind, in accordance with the 'privacy by design' principle. This means that all data from the intelligent cycle path are inherently privacy-proof and secure. For example: the camera images from the 3D cameras are converted into non-privacy sensitive information *within the camera itself*.
As a result, the data measured by the system can be used immediately: no further action is required to ensure GDPR compliance.

Outdoor Mobility Digital twin

Of course, cycling should also be seen in the context of other traffic—pedestrians, public transport, and car traffic. This is why TU Delft is deliberately investing in systems that can observe, analyse and visualise *multimodal* traffic flows. For example, we have set up the Outdoor Mobility Digital twin, OMDt, that brings together various unique data sources and presents them in a 3D dashboard. Partly with the assistance of interpretable artificial intelligence, the OMDt can predict the total multimodal traffic situation several minutes to hours or days in advance. In The Hague, we have already applied this approach in several successful pilots aimed at forecasting (too) large crowds.

TU Delft Campus as a testbed for sustainable mobility

The intelligence cycle path is just one of the many bicycle and mobility innovations being developed on TU Delft Campus. Through these innovations, we are encouraging sustainable transport—on the campus itself, but also beyond it.

In the process, we are exploring different types of interventions, ranging from smarter regulation of traffic lights through to the provision of shared bikes, improved and safer bicycle parking facilities, personalised route information, better connections with bus, tram, and train, etc. Each intervention also takes account of traffic flows, emissions, privacy, and equity (who will benefit from the new services?).

In our efforts to innovate, we also try to factor in the issue of *scarcity*. Think of all the materials currently in short supply. For example, battery-based electrification places huge pressure on raw materials as lithium. But the limited availability of space is also a factor: our road infrastructure takes up a large amount of space. If this infrastructure is arranged more smartly and more sparingly, this will open up opportunities for alternative use, such as sustainable energy generation, for water storage, or for housing and study.

Thanks to this approach, TU Delft Campus is contributing to sustainable mobility in the broadest sense.

Photos: Rick Wink

The Netherlands' most intelligent cycle path is an initiative of two field labs on TU Delft Campus: *Mobility Innovation Centre Delft* (MICD) and *Delft on Internet of Things* (Do IoT).

The 25 m section on TU Delft Campus was laid at the end of 2021. PlasticRoad is the company that developed and manufactured the plastic road components. The laying of the cycle path, construction of the monitoring system, and the data analyses and visualisations have been part-funded by the Rotterdam-The Hague Metropolitan Region (MRDH), the Municipality of Delft, Vialis, and Argaleo.

The scientific research is being coordinated by the TU Delft faculties of *Civil Engineering and Geosciences* and *Electrical Engineering, Mathematics and Computer Science*. In this, TU Delft is working closely with government bodies, businesses, and start-ups.

More information?

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The intelligence cycle path at a glance

Above-ground sensors

Radar: A system featuring Wi-Fi, Bluetooth, and radar. Capable of determining the density of pedestrians and cyclists.

Depth sensor: Used to count the number of cyclists, pedestrians, and cars. Thanks to their very high frequency, these sensors can distinguish between people, animals, bikes, cars, and so on.

Cameras with stereo vision: Measure traffic density, speeds, and trajectories. The video images are analysed *within* the camera before being immediately deleted. Only the results of the analyses are shared.

Weather station: Measures temperature, humidity, precipitation, UV intensity, wind speed, and direction.

Underground sensors

- **Weight sensors**
- **Temperature sensors**
- **Ice sensors**
- **Dirt and water-level sensors**

Sensors beneath the road surface measure traffic intensity, road surface temperature, load, the level of water and dirt on the road, and the movement of the road surface. Electric current is also used to determine the road surface conditions: dry, damp, or wet.