Interaction with pedestrians

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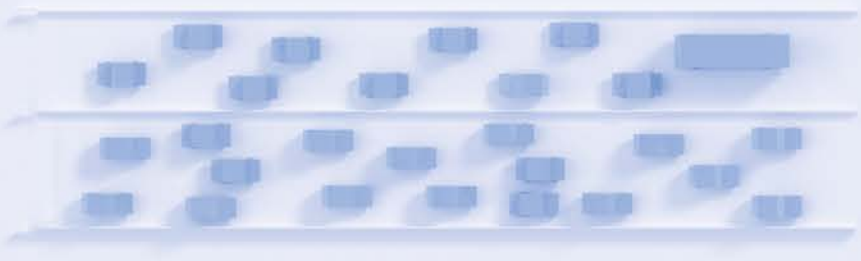
Automated Driving Will Require a **New Traffic Culture**

Automated driving is a vision of the future with more than just technical implications. In creating a safer, efficient, sustainable yet convenient traffic system, the complex interaction between people and vehicles has a central role to play. TUM is engaged in the TEMPUS research project, which hopes to highlight ways that technology and a new traffic culture might influence and shape this relationship.

Graphics: turbosquid, ediundsepp

Road traffic today:
Fixed lanes

Lane-free
traffic



Automated vehicles using cameras and sensors to keep an eye on each other while also exchanging data do not need fixed lanes but can organize themselves depending on the actual traffic situation.

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Automatisiertes Fahren braucht eine neue Verkehrskultur

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Immer stärker automatisierte Fahrzeuge legen die Grundlage für einen sicheren, nachhaltigen und zugleich komfortablen Verkehr in der Zukunft. Viele Prototypen mit ausgeklügelten Regelungen, Sensoren und Kamerasystemen sind technisch bereits weit gereift. Doch auch das komplexe Wechselspiel zwischen Mensch und Fahrzeug muss für einen Erfolg eines automatisierten Verkehrs dringend beachtet werden. Dazu forscht Prof. Klaus Bogenberger mit seinem Lehrstuhl am Projekt TEMPUS. Es soll wichtige, bisher kaum verfügbare Daten aus dem Verkehrsalltag im Norden Münchens liefern, um Technologie und das Verhalten der Menschen in Einklang zu bringen. Dabei spielen optimierte Reaktionen automatisierter Fahrzeuge auf besonders verletzliche Verkehrsteilnehmer wie Fußgängerinnen und Radfahrer eine zentrale Rolle. Zusätzlich werden mit Prototypen und Simulationen neue Konzepte sowohl für den öffentlichen Nahverkehr und Lieferdienste als auch für einen effizienteren Verkehrsfluss ohne jegliche Fahrspuren erprobt. Am Ziel dieser Entwicklung kann eine völlig neuartige Verkehrskultur stehen. □

Vehicles use the road width in an optimal way

Automated vehicles organize themselves in flocks to optimize intersection capacity

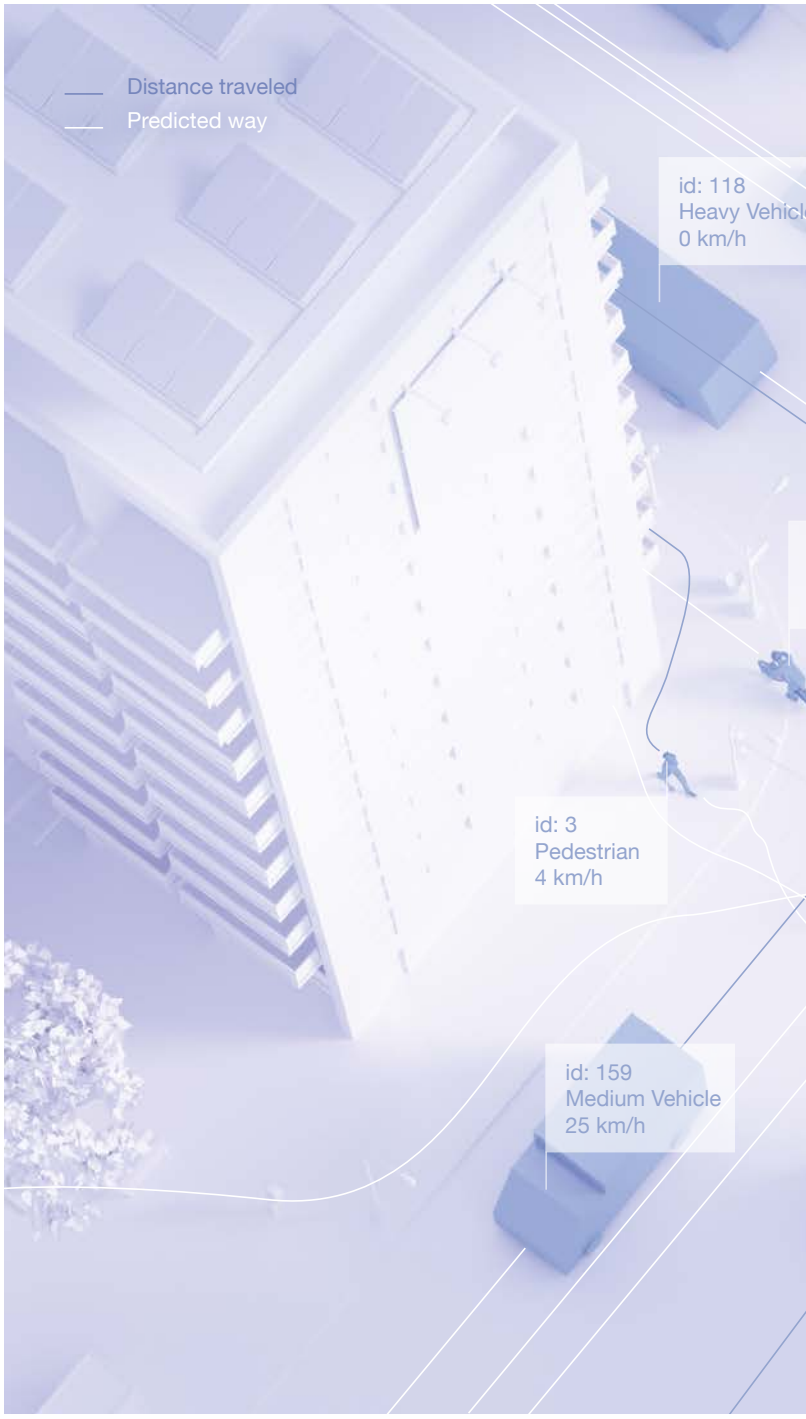
Automated vehicles could enable the same roads to accommodate one-third more traffic than today.

Graphics: turbosquid, ediundsepp (source: TUM)

Anarchy is not uncommon on the roads of Buenos Aires. Many drivers ignore red lights, especially at night. On Avenida del Libertador, one of the city's principal thoroughfares, the drivers treat the 16 clearly marked lanes as a suggestion at best. Nevertheless, vehicles weave their way past each other with uncanny caution along this expansive road. Blaring horns and even accidents are rare events. This traffic culture is certainly no blueprint for a major German city – and yet, a seemingly frenzied tangle across all lanes is a conceivable possibility in Germany in the near future. High numbers of automated vehicles using cameras and sensors to keep an eye on each other while also exchanging data could make this possible. This would take human drivers' attentiveness out of the equation entirely in order to achieve a high degree of safety for all road users. "It would enable the same roads to accommodate one-third more traffic than at present," says Klaus Bogenberger, Professor for Traffic Engineering and Control at TUM.

More fluid traffic on lane-free roads is just one of many forward-looking concepts that the traffic researcher is currently examining in the TEMPUS project along with around a dozen partners from the fields of administration, research, business and industry. The project is funded by the German Federal Ministry for Digital and Transport, its full name is TEMPUS – Testbed Munich – Pilot Test of Urban Automated Road Traffic. TUM project leader is Martin Margreiter, Head of the Chair's Research Group Automated Traffic. Lane-free traffic is among the topics the researchers are currently examining exclusively using computer simulations. However, the TEMPUS project's focus as it seeks to secure a safer, sustainable and convenient future for traffic lies in practical application. How will automated vehicles find their way in traffic? How will they react to pedestrians or cyclists – and vice versa? What rules will be needed to help traffic flow and, above all, to flow safely? And how can we program automated vehicles' control systems to meet these demands? The TEMPUS project, which has been awarded €13 million of funding from the Federal Ministry for Digital and Transport over a 30-month period, aims to find pioneering answers. ▷

"Some automated vehicles will be driving on a TEMPUS testing area as early as this summer," says Bogenberger. Situated in the north of Munich, this testing area stretches from Olympiapark via Unterschleissheim and all the way to the A9 and A99 autobahns. The automated vehicles – including cars from BMW and buses made by the Dutch firm Ebusco – will have to integrate into real traffic, both in urban residential areas and on federal roads and autobahns in rural areas. "This test field includes all road types, making it the first of its kind anywhere around the world," says Bogenberger. The automated vehicles will constantly receive real-time traffic data via high-speed 4G and 5G networks. In addition, crossings will be equipped with intelligent traffic lights, while detection loops in the roads will be used to monitor the vehicles along with cameras and drones. "Another goal for TEMPUS is to standardize data flows," says Bogenberger. As he explains, this is the only way the system will be able to function at every traffic light in Europe in the future.



It is hoped that automated vehicles' intelligent real-time control systems will make it possible to avoid sudden traffic jams and congestion while also benefiting local public transport services. In fact, the TEMPUS partners are testing a system in which an automated bus independently follows a classic bus with a human driver at times of high passenger numbers – like a duckling following its mother. This solution, known as bus platooning, improves the service for public transport passengers while also saving energy and road space. Another sub-project is considering the potential of ride-parcel-pooling as a way to cope with the significant increase in parcel shipments due to the rise of online retail. In this scenario, ride-sharing services – such as the MOIA, a mobility service somewhere between a taxi and local public transport, operated by the Volkswagen Group – pick up and transport both passengers and parcels. This would reduce the number of automated vehicles on the road by making better use of their capacity, thereby reducing traffic levels and congestion.

Interaction with pedestrians and cyclists

"In contrast to many previous pilot projects with automated vehicles, in the TEMPUS project we're focusing in particular on the interaction with pedestrians and cyclists," says Bogenberger. The researchers use cameras and small drones to film real-life traffic over several hours, such as at junctions. They hope this will help them to understand how people react to automated vehicles in different scenarios. The central aim is to develop a vehicle control system capable of avoiding accidents if at all possible and thus prevent injuries to pedestrians and cyclists. One conceivable solution would be programming that gives cyclists priority in high-risk situations rather than doubling down and driving on. It might also instruct cars to brake for pedestrians crossing the road with an arm

Graphics: turbosquid, ediundsepp (source: TUM)

outstretched. Another possibility would be to install light signals on automated vehicles to let pedestrians know they had been seen. Bogenberger expects the project to deliver vital insights for which automated vehicle manufacturers will be extremely grateful. “It’s getting very exciting because there’s only very little data about this worldwide,” explains Bogenberger. ▷

Within the TEMPUS project, drones will observe real-life traffic such as at junctions in order to understand how cyclists and pedestrians interact with automated vehicles.

▽ Left: The researchers develop a traffic model for the city of Munich. Right: Specially constructed rickshaws are used for pilot trials on ride-parcel-pooling and automated traffic.

△ A field trial with a rickshaw investigates the potential of ride-parcel pooling to improve environmental and transportation parameters.

Prof. Klaus Bogenberger

After studying civil engineering at TUM, Klaus Bogenberger focused his attention on traffic planning. He received his doctorate in this field in 2001 and was awarded the Heureka Award for Young Scientists. Bogenberger gained industrial experience in roles at the BMW Group and, from 2008, as a managing partner in Munich-based firm Transver. He was appointed a full professor in Traffic Research at the Institute of Spatial Planning and Transportation at the Universität der Bundeswehr München and has held the Chair of Traffic Engineering and Control at TUM since 2020. His working group concentrates on complex simulations of traffic flow theories in cities and on motorways. Further research focuses include sharing systems and new forms of local public transport, such as on-demand services, robot-taxi systems and urban ropeways.

However, the traffic engineer is especially proud of one aspect of the TEMPUS project in particular: “By working with local authorities, industry and research, we have been able to bring all key stakeholders together. That’s not an easy task in the transport sector.” In addition, TEMPUS has made citizen participation a top priority, inviting them to contribute their experiences with automated vehicles via various channels and at local events. Bogenberger believes that local authorities, as citizens’ representatives, have an important responsibility to lay the cornerstones of a new traffic culture. “They have jurisdiction over transport matters and now have the opportunity to draw up rules. They don’t need to wait for guidelines from technology firms,” he says. In many cases, Bogenberger explains, local authorities are not even aware of the influential power they hold.

So, how does Bogenberger assess the likelihood of vehicles scurrying along paying no attention to lanes? “It could become a reality, most likely on motorways. However, it would require an awful lot of automated vehicles in traffic.” That time could come, he suggests, in the next few years. “After all, the dynamic electromobility landscape we have today got off to a very slow start a few years ago,” he says, as he looks to an automated future for traffic.

Jan Oliver Löfken

Picture credit: Stefan Woidig