Smart Mobility
Driven by Technology

Technische Universiteit Eindhoven
University of Technology
Where innovation starts
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At Eindhoven University of Technology (TU/e) we work on breakthrough technological solutions for the societal challenges in the areas of mobility, health and energy. At a global level we have strong research partnerships with industry, focusing on high-tech systems, high-tech materials and data science. It is our aim to inspire students and employees to pursue exciting educational programs and breakthrough research that are beneficial for us all.

Our society faces tremendous challenges in the fields of energy, health and mobility. We believe technology is crucial in finding solutions for both societal and technological challenges and want to contribute significantly with our research and innovation activities. TU/e is helping to build a sustainable world with groundbreaking research and high quality education.

Our activities are embedded in strong partnerships with industry, governments and knowledge institutions worldwide. TU/e is situated in Eindhoven, the Brainport region also known as the technological heart of the Netherlands.
“Mobility has brought huge benefits to mankind. However it clearly brings negative consequences, which can best be expressed by calculating the financial consequences of these negative side effects, such as accidents, congestion and pollution. These negative effects add up to 3-5% of Gross Domestic Product all over the world. However, at TU/e we see many opportunities to use the potential of technology to solve the problems of mobility by adding smartness to it. And in parallel further maintain and extend the added value of mobility by safeguarding and increasing the availability and accessibility of mobility.

A productive and efficient traffic network calls for smart planning and communication. For well-organized logistics and traffic flows to ensure, for example, that there are no empty trucks on the road. For models that will provide insight into the future mobility needs of people, so we can act accordingly. And for Intelligent Transport Systems: vehicles that communicate with one another, their drivers, and the environment and can travel safely, without delays, through traffic. We develop the road towards in-car centric traffic management that will soon make those dynamic routing panels and other roadside equipment redundant.”

We are convinced that we can use our technological innovation to safeguard the social and economical benefits from mobility, by decreasing the societal costs of mobility from 3-5% of GDP towards 0%, and in parallel maintain and extend accessibility of mobility. That means inherently safe and clean mobility, superefficient logistics and a world where traffic jams are a voluntary event.

Dr.ir. Carlo van de Weijer
Director, TU/e Strategic Area Smart Mobility
“We are continuing to work on cooperative and autonomous vehicles and intelligent transport systems, but we also need to think further ahead. Think outside the box and take energy consumption, environment and road capacity, and the individual footprint into consideration.”

Prof. dr. Henk Nijmeijer, Automotive Technology

“Coordination, consolidation, and collaboration are the new credos in the field of logistics. This will consolidate volumes and increase the load factor. The ideal picture? To have as many full vehicles as possible travelling from Point A to Point B at exactly the right time.”

Prof. dr. Tom van Woensel, Transport & Logistics
“To radically reduce our dependence on nonrenewable energy and material sources, we need to improve existing energy conversion technologies for combustion engines or hybrid and electric vehicles. We’ve plucked all the low-hanging fruit; now, we need to strain even harder to get to the fruit at the top of the tree.”

Prof. dr. Elena Lomonova, Automotive Technology

“How do people travel? When and where to? That is the kind of information we need to design cities and traffic networks well. By using models to chart mobility issues, we contribute to smart mobility.”

Prof. dr. Harry Timmermans, Mobility & Traffic
The Strategic Area Smart Mobility combines multidisciplinary research to further strengthen the societal impact of Eindhoven University of Technology in the area of mobility.

Mission

Mobility has brought huge benefits to mankind. But it clearly has negative side-effects. These can best be expressed by calculating their financial impact, such as accidents, congestion and pollution. We aim to use the potential of technology to solve the problems of mobility through smart solutions. And at the same time, we intend to maintain and further extend the added value of mobility by safeguarding and increasing its accessibility.

Program lines

Realizing the mission and the key goals for research will require innovations in five research themes or program lines. A program line is a dedicated, interdisciplinary roadmap developing innovative solutions within the domain on which we focus. The content of each program line focuses on specific application areas in which TU/e already was a prominent research position that is relevant to the societal mission:

1. Safer Mobility - focus on preventing accidents
   - Advanced Driver Assistance Systems
   - Connected and autonomous driving

2. Clean and Energy efficient mobility
   - Alternative Fuels
   - Electric Drive
   - Engines & Power Trains

3. Less Congestion, Efficient Logistics
   - (Urban) Logistics
   - Distributed Traffic Management

4. Solving space problems for mobility
   - New Mobility Systems
   - Smart Urban Planning

5. Ensuring and extend accessibility of mobility
   - New Mobility services

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Automotive Student Teams
Within the Strategic Area Smart Mobility, TU/e focuses on the societal challenges through research. And by students who represent the ideas of tomorrow.

Scientific education, research and valorization blossom within the Automotive student teams that develop and build different vehicles to compete internationally with other university teams. Vehicles in which the students put theoretical solutions to societal challenges into practice. With a good understanding, plenty of enthusiasm and together with equal minded sponsors and professors.

TU/e has six Automotive student teams: Solar Team Eindhoven (STE), University Racing Eindhoven (URE), TU/ecomotive, Storm, InMotion and CADE.
Smart logistics: 4C4More

In the field of distribution, clients are becoming more demanding, while the complexity of product requests, production, and distribution networks continue to grow. These trends, combined with the need for more efficient and sustainable goods transport, are placing great demands on the compact between service providers, manufacturers, and retailers. The key idea behind 4C4More is to create economies of scale through partnerships within and between distribution chains. This includes developing the necessary legal framework and information support for such partnerships, as well as computational models and decision supporting software for predicting demand and transport planning. Several universities, RSM, and six manufacturers and logistical service providers are participating in this project with TU/e. The concrete results will be cheaper production, transportation, and storage, using fewer materials and with fewer emissions.

Cooperative driving

TU/e is working to make cooperative driving a reality. Wireless communication is used to regulate speed and distance between vehicles with Cooperative Adaptive Cruise Control (C-ACC). In C-ACC, information on variables such as speed and acceleration is obtained from other vehicles on the road using a wireless link. The corresponding controller ensures that any changes in speed by the driver in front of you are immediately registered in the cooperative vehicle, which allows for very short inter-vehicle distances without compromising safety. Consequently, road throughput can be improved and aerodynamic drag reduces. TU/e has successfully installed a C-ACC controller in a DAF truck, and in 2011, it participated in the Grand Cooperative Driving Challenge on the highway between Helmond and Eindhoven. In close cooperation with TNO, three passenger cars have been equipped with a prototype C-ACC system, which currently serve as an experimental setup for PhD projects on networked control and interconnected vehicle systems, TU/e actively participates in the European project i-GAME,
which focuses on cooperative behavior of automated vehicles on highways and intersections. Cooperative driving combines a lot of technologies and disciplines, such as control, engineering, software engineering, electrical engineering, embedded systems, vehicle dynamics, and human-machine interactions.

**Electric car: Lupo EL**

Battery electric vehicles are a suitable path to reduce the dependency on oil, to allow driving with zero local emissions in city centers and to reduce CO₂ emissions when powered with electricity from renewable sources. The Lupo EL is a fully electric research vehicle developed by TU/e using a VW Lupo 3L as donor vehicle. Researchers completely replaced the diesel powertrain with an electric one. The energy is stored in batteries with a combined weight of 273 kg. The resulting vehicle has an interesting combination of a relatively low mass (1060 kg), large battery capacity (27 kWh), and good range (170 km @ 100 km/h) and performance (0-100 km/h in 12 seconds). Thanks to these optimal specifications, the car won first prize in the Michelin Challenge Bibendum, 2011, in Berlin. The Lupo EL can be a striking duo together with the DAF truck when it comes to cooperative driving.

**Cargo Hitching**

Combining people and freight flows creates attractive business opportunities because the same transportation needs can be met with fewer vehicles and drivers. This can make socially desirable transport options economically viable in rural areas where the population is declining. In urban areas it reduces congestion and air pollution and facilitates the introduction of electric vehicles. This project will design integrated people and freight synchromodal transportation networks and the related coordination (4C), planning and scheduling policies to enable efficient and reliable delivery of both persons and small- to medium-sized freight volumes.
Society’s need for highly educated, multidisciplinary engineers in the field of logistics and automotive science is increasing rapidly. That is why TU/e invests in educational programs to prepare students and young researchers for a career in Smart Mobility. Our students learn how to work in teams to solve, with great passion, the technological challenges in a number of extremely important social issues.

**Education options in Smart Mobility at TU/e**

Smart cars will help make clean driving and fewer traffic jams a reality. But to get the most out of the technologies in terms of efficiency, we must design vehicles based on a full system analysis and work towards optimizing the parts of a vehicle that work together. At least 50% of the added value in new cars is achieved through microprocessors: electric, electromagnetic, and network components. The challenge in the automotive industry is to ensure that the integration of these embedded subsystems does not affect reliability, safety, or profitability. Creating a car like a computer on wheels will also require well-educated, multidisciplinary engineers.

Logistics ensures that products are delivered to clients on time, at a low cost, and with little environmental impact. With good planning, products can arrive at their destination without delay on cost-effective trucks that are optimally loaded. This is how engineers with logistical knowledge can make an important contribution to intelligent and productive mobility.

TU/e offers a range of education options in the field of Smart Mobility. In 2011, we launched the first university Bachelor program in Automotive. We also have two Master programs and two Designer programs available in the domain of Smart Mobility. Approximately 1,700 TU/e students are exposed to automotive or logistics related subjects during their education.
Automotive Education:
- Bachelor in Automotive
- Master in Automotive Technology
- PDEng in Automotive Systems Design
- PhD projects in Automotive Technology

Transport and Logistics Education:
- Logistics is one of the options in the Industrial Engineering & Management Sciences Bachelor's program
- Master in Operations Management & Logistics, Master in Innovation Management
- PDEng in Industrial Engineering
- PhD projects on Industrial Engineering in the Logistics & Mobility domain
As an internationally recognized research university, TU/e plays a key role in the Brainport region, where knowledge institutes and industry cooperate intensively. TU/e is located in the hub of the Dutch automotive industry, which is concentrated in the southern Netherlands.

Smart Mobility
innovations and valorization

In developing innovations TU/e enjoys a long-standing and close cooperation with strategic partners. Within the area of mobility, TU/e is a strong partner of the nearby Automotive Campus in Helmond and the Dutch Institute for Advanced Logistics (Dinalog) in Breda. As a founder or scientific associate it is also closely linked to public private innovation programs such as AutomotiveNL in Helmond and Logistics and Supply Chain Management. TU/e is one of the founding key members in DITCM, the Dutch Integrated Test Site Cooperative Mobility, an open development environment located in the south of Brabant. Other parties involved in this still expanding collaboration include TomTom, DAF/Paccar, NXP, SKF, Imtech, Audi, TNO Automotive. TU/e works intensively with TNO and the Dutch Ministry of Infrastructure and Environment to create a unique knowledge and innovation network to address automotive, logistics, and traffic management issues. Internationally, TU/e has acquired a strong position in a large network of partners. For instance, it is linked to a number of international research programs, such as the European Supply Chain Forum, iMobility Forum, Vehicle&Road Automation, EARPA, and the Green Car Initiative. The university also has extensive contacts with other research institutes like Fraunhofer and partner universities abroad in EuroTech with TU Munich, EPFL Lausanne and DTU Denmark, and works closely with MIT’s Center for Transportation and Logistics.
Spin-off: Progression Industry
Progression Industry, one of the TU/e’s successfully launched spin-offs, is working on green technologies for the automotive industry. The company has developed WEDACS technology for petrol engines, which reduces the amount of petrol used and increases engine torque.

The most recent developments are related to the second generation of biodiesel: Cyclox. TU/e is collaborating with Progression Industry to introduce the world’s first lignin based low soot diesel fuel for marine applications.
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