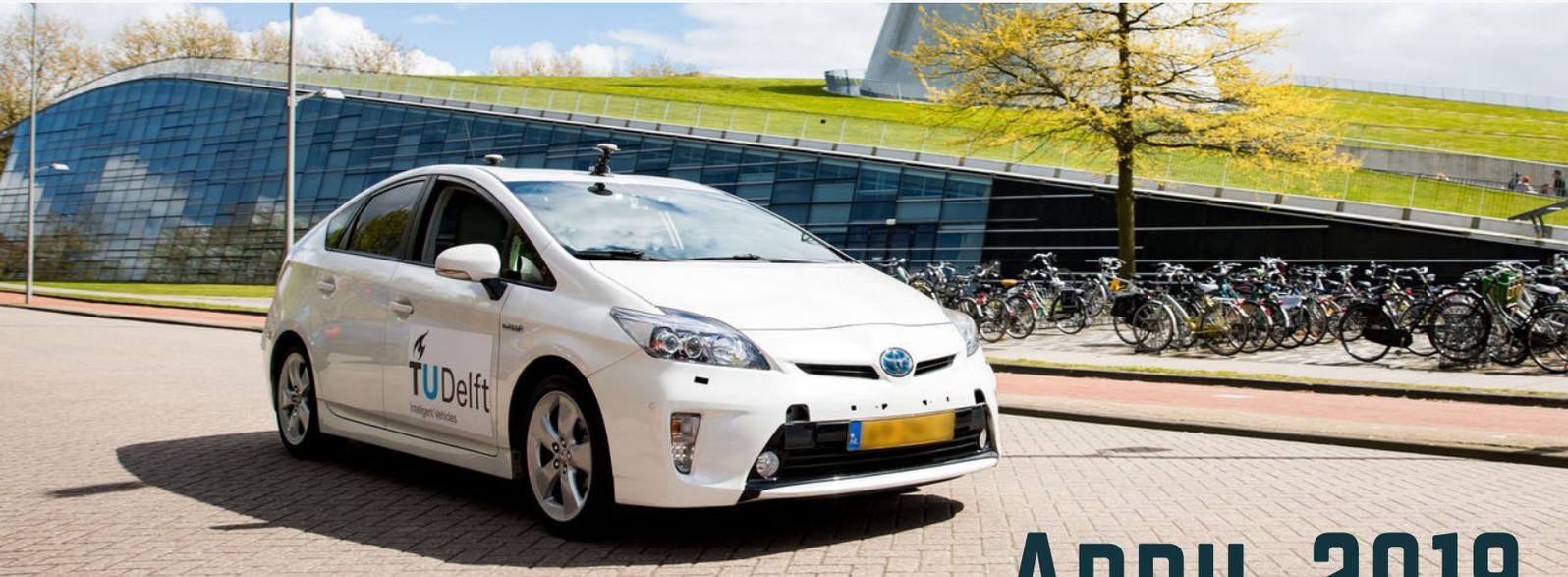
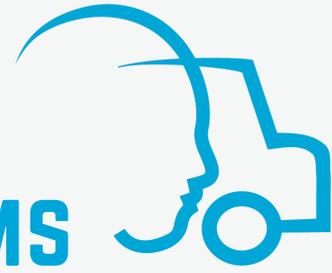


MEANINGFUL HUMAN CONTROL OVER AUTOMATED DRIVING SYSTEMS



APRIL 2019

THIS ISSUE'S TOPICS

THE EDITORIAL

Automated vehicles make our lives easier - or do they?
by *Daniël Heikoop*

THE INTERVIEW

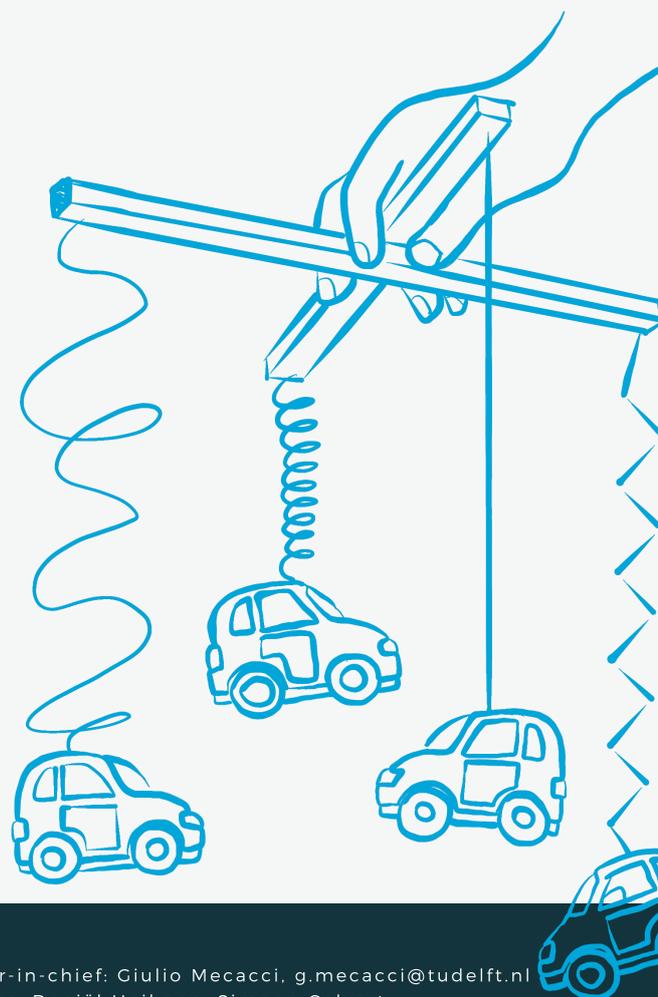
For this issue, we interviewed Mark Maaskant, specialist on EVs and ADAS, about driver training in a world of rapidly advancing technology.

NEWS FROM OUR PROJECT

Our updates on research and things we do in our daily life of hard working researchers.

PUBLICATIONS AND DISSEMINATION

A short list of our most recent publications, the events we attended, and those we are planning to attend.



COLOPHON

Meaningful Human Control newsletter
TU Delft

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Editors: Daniël Heikoop, Simeon Calvert



Photo by Bruce Mars

THE EDITORIAL



AUTOMATED VEHICLES MAKE OUR LIFE EASIER... OR DO THEY?

by Daniël Heikoop

For everyone that reads this editorial, it may come as no surprise that the statement in the title is not that easy to make. Not only does it come with the difficult question of who is responsible of the safe driving of the vehicle during different levels of automation, but it also comes with novel tasks, and therefore novel responsibilities to the driver, for which he or she has not been trained during their regular driver training course.

A recently published article from the MHC team illustrates –in a quantitative manner– how the amount of skills we need to address during driving migrates inconsistently over the levels of automation. Moreover, the amount of novel tasks that are being introduced by driving with an automated vehicle even increases in the early stages, and is further on still heavily dependent on how we as society will deal with more and more autonomy. And this is where it becomes tricky, because of a threefold reason. Firstly, and most simply seen, novel technologies introduce novel tasks, as stated before. Secondly, these novel tasks ought to be trained, ideally. But, thirdly, –and here comes the major problem– we are not; and it does not seem likely that we will in the foreseeable future. Even though we are slowly but surely becoming aware of the Human Factors problems that arise due to the rapid introduction of increasingly autonomous vehicles and automated driving systems, there appears to be another issue that halts the progress in tackling these problems, namely the issue of who is responsible of teaching us how to drive with them? All along the development line, everyone seems to be reluctant to take up this role, and this is a difficult situation.

The buyer of a new car gets the car without any instruction on the advanced driver assistance systems (ADAS) features in his/her new car –apart from the beefy manual–, and safely drives off into the sunset. Well... safely? Let's assume the buyer actually uses the new ADAS feature; something that isn't that straightforward to begin with, but we'll leave that one be for now. Let's turn on the ADAS. Ehrm... how? Where's the button? Is there a button? Which page in the manual? That's lesson one for you.

When you drive with ADAS, new tasks are being introduced, and some of them are required to be turned into a skill. Consider a system that actively requires you to produce continuous input, like placing your hands on the wheel every time the system beeps. You've definitely not learned that during your regular driver training course. Or looking far ahead, hovering your foot over the break, to make sure you cancel your ACC in time exiting the freeway. With the introduction of novel systems, you get novel tasks to learn. So how can we learn those? The most plausible way of doing this is by incorporating it into your regular (manual) driver training course, as with that, you'll be taught by qualified professional teachers. But in order for this to be viable, driving instructors first need to know how to train people to drive with ADAS, and therefore need to know for themselves how these systems work. Who will enable that? This requires a thought shift from higher up, and for society in general. On the one hand, us as society should become aware of safety-related issues with ADAS. Simply put, we should understand that ADAS are no magical machines that avoid all danger but are merely there to facilitate safer and more comfortable driving. On the other hand, we should make safety more of a priority than it currently is. ADAS are in essence wonderful pieces of machinery, but they are being built because... well... because we can, and not because they're safe; that's just a bonus. As soon as we start realizing that safety is important to us as society, we can start ushering in novel concepts that can safeguard responsible designing of systems so that they will be, and stay, safe to drive with. Not in the least will we want some form of meaningful control over the system by its user. But who can we ask about what is a meaningful form of control? Who knows best what we can and cannot do in a car? That's right, the driving instructors. So designers and instructors should ideally sit together, which could be facilitated by relevant stakeholders. So, governments and other policy-makers should be added into the mix to promote awareness using information campaigns like those regularly seen along the roads and on TV. Ultimately, we're all supposed to be in this together, because researchers like me explore the caveats and (hope to) come up with solutions to fill them. Addressing problems before they become full-fledged, and working together with stakeholders such as OEMs or legislator bodies, we aim to steer us in the safest direction. So, to summarize, we're all needed. Together we stand, for a safer future.



THE INTERVIEW

MARK MAASKANT, PRODRIVE AND DRIVING TRAINING

Mark Maaskant, 1978, specialist on EV's and ADAS. Is convinced that advanced driver assistance systems combined with proper use thereof will lead to safer traffic. Also owner of Prodrive Academy and VVCR Europe BV, where the use of ADAS in both person- and freight vehicles is being explained to the user as much as possible, with the goal of having ADAS used more often and in the right way under the right circumstances. Drives himself a Tesla because the ADAS are being updated constantly and run in beta, due to which you "can look a little bit into the future" regarding what is coming in the area of driver assistance systems.

Prodrive is a driver training company that uses brand perception and education to aim for zero deaths in traffic and a more sustainable world with a more long-term focus. They support the use of ADAS for a safer and more comfortable driving experience.

We invited Mark for an interview to talk about what they do, what they think of the rapidly developing vehicle technology, and how we should tackle occurring challenges with ADAS.

So, your company provides training with ADAS. What does that entail?

The client asks us for a training with ADAS, since they're interested in what their car can and cannot do, how to drive with those systems, and what features are actually in their car to begin with. So, we start with a hardware walk-around of the owner's car, and then we show them the workings of the various systems, such as ACC, LKA, et cetera. Plus we also show them how their car's connectivity works, so how it for instance integrates with their mobile phone.

Is this the standard procedure for all your trainings given at Prodrive?

All of our training is focused on the detection of danger and the motivation of using safety systems. About 90% covers the use of driver assistance systems, and I think about half of them is about the advanced, automated kind (ADAS).

Why is this such a (relative) large account?

Most people that come to us are either unaware of the workings, or unaware of the existence of these assistance systems altogether. They have lots of questions, and often they think it's scary to use them. The transfer of control to an automated driving system is of big concern to them.

Is this sense of loss of control really such a problem to them?

Well, not to all, but in essence, yes. Only those who are early-adopters, the thrill-seekers, they of course are actively looking for this.

What are the benefits of doing a training with ADAS at your company?

First and foremost, OEMs develop ADAS for safety purposes, so if we can get people to understand what their cars can do, and how to drive with them, they would, in theory, automatically drive safer. For instance, using a traffic jam assistant will in at least 99,9% of the cases avoid you crashing into a car in the jam up ahead. It's just highly unlikely that if you use this system, such an accident will occur. Imagine not using this system, because you're not aware of it. That's just a shame, to say the least. Our training makes them aware of systems like these. It makes a big impact.

So why then isn't everyone taking your ADAS training course?

Money, of course, plus the fact that most drivers are just simply oblivious to the problem. Add that to the fact that most (either private or company) don't consider safety a priority, and don't consider them responsible for this, it's easy to see why this is not working as well as it should. For the first problem, we have developed a concept, though, the Lease concept, which incorporates the training into the monthly lease fees; you are talking of an amount of less than 4 euro's per month.

Does that work?

Growing, but it's still difficult. The necessity is still hard to find for companies, and investing in safety will always remain a difficult issue. Road safety isn't necessarily seen as a potential hazard with Dutch employers.

So, in general, do we still not use ADAS enough?

Well, in fact, the problem lies with the fact that there are still too few cars being ordered that contain ADAS in the first place. This is also because safety of little concern to most, and because people still simply don't know enough about ADAS. Second reason is, it makes the care more expensive which results in a high amount of tax people have to pay in private for using a company car.

Do you consider this to be the major problem, or is the misuse of ADAS a bigger problem?

Misuse can be considered in two ways. Misuse on the one hand, and overestimation on the other.

So what is the most common problem, seen from the human driver, and from the technique?

Under- and overestimation of the ADAS for the human, and reactive versus proactive handling for the technique.

Is this because of ignorance or because of complacency from the user?

There really are too many options inside the car of today. Therefore, people are being overwhelmed. That, and usually people take a passive stance, and await what they will be taught in the training, rather than investigating themselves, you know, like RTFM.

Or do you think that the use of the wrong terminology is an overly big problem in relation to misuse of ADAS?

The character of people who actively use ADAS are usually those of early-adopters, which are thrill-seekers, and such. So, I suppose that's one reason why ADAS are misused. Also the media blows things out of proportion, making these systems look better than they are. It takes a while of driving with those systems to know better.

So experience is the only key to success, in relation to ADAS?

Yes, and a training with them is a good start.

If we want to tell the user where the gain in using ADAS lies in relation to effectivity, where would that be?

On the one hand, if they don't use ADAS, on longer trips they would become less alert, and would in essence start to drive worse. Plus, using ADAS would enhance traffic flow. On the other hand, most of the current ADAS are still not good enough, as they are mostly reactive, rather than proactive, and are therefore also not economical, but rather the opposite.

How would a proactive ADAS look like, according to you?

Well, as an example, Tesla's are currently looking 3 cars ahead, so if you would have a system that breaks if a car 3 or ideally even 5 cars ahead starts to break, that would be a step towards the right direction. Also, communication is key here. For instance using 5G to communicate with other vehicles, but also to the infrastructure, and everything else around it. V2X. And using dynamic speeds, and smarter, not more asphalt.

Aren't you afraid that users will lose the skill to drive manually when using ADAS (too) often?

No, not at all. ADAS should have a good interaction with its user. Then that should not become a problem. In fact, it may even allow them to focus on other parts of the drive, those that usually take too much energy. Using ADAS might save some energy, for instance on long stretches on the highway, and that saved energy may then be used on busy intersections once they exit the highway.

What would, according to you, be a meaningful form of human control over an automated driving system?

The technique inside should be useful, meaningful, for the human driver, and assisting instead of leading, for instance from entrance to exit on a highway; in other terms, facilitating. To achieve that, policy and legislation makers should engage in joined-up thinking regarding this.

In your opinion, is it important for the driver of the vehicle to ultimately remain in control of the vehicle, even if the ADAS are capable of performing the driving task completely, or can the control over the vehicle be placed at someone else, for instance the software, and with that, the OEM or designer/programmer, or someone like that?

As it currently stands, the driver should always be able to overrule control of his/her vehicle. But if we are going to think about level 3-4 automated driving systems, which currently don't really exist, then we should first consider what level of V2I exists, and what the quality of that is, before we can start talking about that.

So, more, or different requirements are needed in the classification of automated vehicles?

Yes, that would, in my eyes, be appropriate. As I said, at least V2I/V2X communication should be incorporated somehow.

Who would be ultimately responsible for securing safe and appropriate driving with ADAS?

The OEMs, because of the goal they have intended for their vehicles, and because of national differences between importers. The OEMs are in that the common denominator, so they should take the responsibility for this.

Last question: do ADAS make driving safer?

Yes, and more economical too, if they become proactive.

NEWS FROM OUR TEAM



Dr. Simeon Calvert, traffic engineer

The past period has involved a range of different efforts for the engineering and impacts parts of the project. The conceptual simulation framework for automated driving has been completed, which paves the way to look into ways to operationalise MHC in the framework later in the year. This will take place in close collaboration with the other disciplines and should result in the application in a further case study. Work is still ongoing in regard to the core components framework, which requires expansion with conceptual aspects in regard to operationalisation of MHC before it can be published. This seems to be a recurring, but nonetheless important, theme. Therefore, we are taking our time to properly ensure that operationalisation of MHC can be achieved. In the coming weeks, we expect to start with efforts to consider MHC in an urban environment for X2X communication with infrastructure and other (cooperative and/or automated) vehicles. This is going to be an interesting, but changing, work that we will undertake together with the University of Glasgow. Looking further ahead, we hope to also perform a driving simulator experiment on the transition of control that should give us greater insights into human mechanisms under such circumstances. Finally, we are looking ahead towards the end of the calendar year to performing case studies by applying the MHC theory. One of these will be in relation to truck-platooning with the other still open for discussion.



Dr. Daniël Heikoop, behavioral scientist

As we've published our first journal article, and followed up on that by organising a focus group discussion with Dutch driving examiners, it was time to do some hands on empirical research. This is what is currently being done. Preparations are in full swing, and we are almost ready to go. The experiment will consist of a driving simulator, in which we will ask a group of at least 100 participants to drive along a simulated course, transitioning between manually and automated driving, after which we will investigate how or whether different personalities behave differently whilst driving with, to, and from automated driving systems. Since it is a big experiment, with at least 100 participants, and recruitment of them is also an important part of the study, this will take quite some time. We are also about to recruit those 100 participants, by selecting them based on the Big Five Inventory, which means that we (hope to) select 20 participants for each of the 5 big personality traits. For this, we ask the help of our partners within the MHC consortium, so don't be surprised if we ask one of you soon. Without you, it would be an impossible job. Of course, this could also not be done without the help of our students. We have assigned two of them on this already, and need at least one more. Lastly, I will not forget about publishing what we have done during the focus group discussion, and what we can and aim to do with the answers we got during that day. There is a draft ready, but it needs some more time and work for it to become ready to submit to a journal.



Dr. Giulio Mecacci, philosopher of mind and technology

The last few months have been very generous in terms of research ideas. Our first big foundational paper on the conceptual grounding of meaningful human control is still under review, and in the meantime we are exploring other related questions. For instance, one of the current philosophical investigations is dedicated to understand how to keep alive moral responsibility when technology seems to progressively less clear who the responsible is for the actions of systems. We see that one of the tempting solutions is what we call 'legal solutionism': solving morally relevant dilemmas by stipulating morally neutral liability agreements. Another one of our current lines of research regards the value of safety in the self-driving industry, its use and its abuse in pushing the technology to the public. If on the one hand we need more elements (not just a lot of miles) to determine how safe a vehicle is (the meaningful human control conditions might provide some), on the other hand we think that other values, such as moral accountability, should be taken into better consideration within the societal debate (and again, MHC can provide important insights). Finally, in our strive to operationalise meaningful human control and make clear its possible applications, we joined our forces with colleagues in Glasgow, to see how we can use some of our insights in application to an urban environment, where the number and the variety of road users, with hardly predictable behavior, make human control and transparency extra challenging.

PUBLICATIONS AND DISSEMINATION

Journal articles (submitted)

- S. C. Calvert, D. D. Heikoop, and B. v. Arem (submitted). "Core Components of Automated Driving for Meaningful Traffic Flow and Safety."
- S. C. Calvert, G. Mecacci, B. Van Arem, F. Santoni de Sio, D. D. Heikoop, & M. Hagenzieker (submitted). "Gaps in the Control of Automated Vehicles on Roads".
- G. Mecacci & F. Santoni de Sio (submitted). "Meaningful Human Control, Practical Reasoning, and Dual-Mode Vehicles".

Journal articles (published)

- F. Santoni de Sio & J. v. d. Hoven (2018) "Meaningful Human Control Over Autonomous Systems: A Philosophical Account", *Frontiers in Robotics and AI*. doi: 10.3389/frobt.2018.00015.
- D. D. Heikoop, M. Hagenzieker, G. Mecacci, S. Calvert, F. Santoni de Sio, & B. van Arem (2019). "Human Behaviour with Automated Driving Systems: A Quantitative Framework for Meaningful Human Control". *Theoretical Issues in Ergonomics Science*. doi:10.1080/1463922X.2019.1574931.

Conference papers

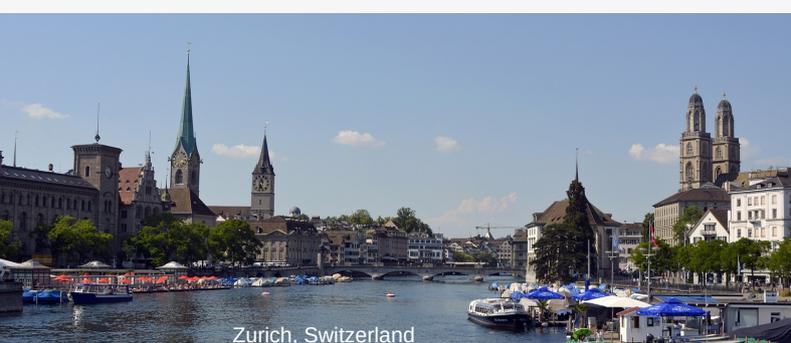
- D. D. Heikoop, & M. Hagenzieker (2018). "Working Towards a Meaningful Transition of Human Control over Automated Driving Systems", In: Victor T., Bruyas M.P., Regan M., Brusque C., Fort A. and Jallais C. (Eds.), 2018. *Proceedings of the 6th Driver Distraction and Inattention conference*, Gothenburg, Sweden, October 15-17, 2018 (online).
- S. C. Calvert, G. Mecacci, D. D. Heikoop, & F. Santoni de Sio (2018). "Full Platoon Control in Truck Platooning: A Meaningful Human Control Perspective". *IEEE ITSC conference*, November 4-7, 2018, Maui, USA.

Abstracts

- A. Tsapi, & J. A. M. Vissers (2019). "Meaningful Human Control over Automated Driving Systems: Consequences for Driver Training and Driver Testing", *CIECA Congress*, June 7, Tbilisi, Georgia.
- F. Santoni de Sio G. Mecacci. (2019) "Meaningful Human Control over Robots in the Security Sector", *Autonomous Security Systems conference*, May 2-3, Zurich.
- D. D. Heikoop & M. Hagenzieker (2019). "Menselijk gedrag met automatische rijsystemen: Een kwantitatief raamwerk voor zinvolle menselijke controle", *10e VerkeersGedragDag*, April 3, Utrecht, The Netherlands.
- S. C. Calvert, & D. D. Heikoop (2018). "Vehicle Automation Design to Maintain Meaningful Human Control for Driver Inattention", *6th International Conference on Driver distraction and Inattention*, October 15-17, 2018, Gothenburg, Sweden.
- D. D. Heikoop, & M. Hagenzieker (2018). "Working Towards a Meaningful Transition of Human Control over Automated Driving Systems", *6th International Conference on Driver Distraction and Inattention*, October 15-17, Gothenburg, Sweden.
- D. D. Heikoop, M. Hagenzieker, G. Mecacci, F. Santoni de Sio, S. Calvert, & B. van Arem (2018). "Meaningful Human Control over Automated Driving Systems", *6th HUMANIST Conference*, June 13-14, The Hague, The Netherlands.

Media appearances

- VPRO Tegenlicht Meet Up "De Rijdende Robot", interview with F. Santoni de Sio. April 10, 2019, Follow the livestream! [🔗 FORTHCOMING!](#)
- "Dit is de toekomst van zelfdenkende voertuigen", Interview NOS Nieuwsuur (tv), June 17, 2018, 22:00 hrs. Interview with (a.o.) M. Hagenzieker & B. van Arem [🔗](#)
- Article on the website of the TBM faculty [🔗](#)



Zürich, Switzerland