MeBeSafe News

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MeBeSafe measures REVEALED

See summaries and illustrations of what the MeBeSafe concepts aim to change - and get a better understanding of how they can be applied to make traffic safer.

The cyclist nudge aims to reduce cyclist speed when necessary. It is made by completely flat stripes running across a biking lane. The stripes are getting closer and closer together.

This will create an illusion that you are going faster than you actually are, which will make it more likely that you slow down. MeBeSafe found the nudge to work even when it was not noticed at all.

The InfraDriver nudge aims to reduce speed for car drivers when necessary. It is made by a row of lamps on either side of a road. When a driver goes too fast, the lamps will light up in a sequence to make it look like they are moving towards the driver and the driver will think they are going faster than they are.

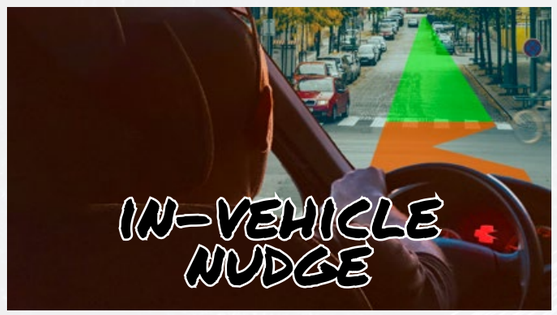
Another version of the nudge uses static lights as a way to warn the drivers of impending danger.

The Habit Coaching aims to help drivers in starting to use Adaptive Cruise Control (ACC) in their cars. The coaching is centred on introducing drivers to the concept, so that they later can be nudged by the closely related ACC-Nudge.

Adaptive Cruise Control is more safe than standard cruise control, as it will never run into a slower car in front. Instead it will keep following behind.

The ACC-Nudge aims to make drivers use Adaptive Cruise Control (ACC) more often. Conceptually it consists of an interface with free-flowing bubbles.

The scattered bubbles get more and more orderly when the driver uses ACC more often. It appeals to the human desire for order, making it a rather apparent nudge. As many people don't use ACC, they will first be coached to do so with the Habit Coaching.



The In-Vehicle Nudge aims to direct drivers' attention to cyclists. It can be projected in the windscreen as a green line along the road. When a cyclist comes, the line turns red and gets a notch at the side where the cyclist approaches from.

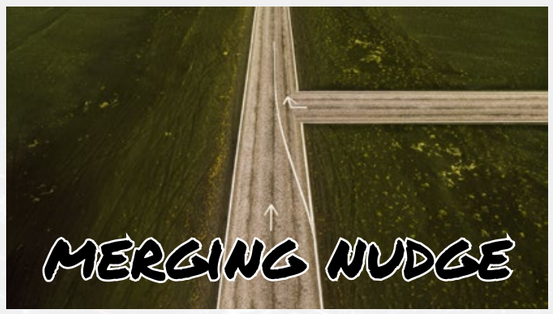
The adaptation for the Field Trial is placed in the instrument panel of the car. It uses a symbol representing the shape of the upcoming intersection.

The coaching app aims to help truckers improve their driving by peer-to-peer coaching. Data on driving behaviour is collected by the app and shared with nobody else than the driver.

The app will suggest a time when two peers should meet and coach each others, based on an analysis of the data. It will give suggestions on what they should discuss at that coaching session.

The take-a-break reward is similar to a nudge, except that it rewards people. It aims to make tired drivers more likely to stop and take a rest.

When a driver is found to be tired, a sign will light up in the car telling them about a reward if they stop to take a break. Over time the rewards will change, from free cinema tickets to a cup of coffee at the nearest café.



The merging nudge aims to reduce the amount of conflicts when two single-track bike lanes meet in a T-intersection. Conceptually, it is made by creating an entrance ramp with a line, giving space for cyclists to enter the more busy lane.

The nudge was tried and evaluated in the pre-studies, but it will not be part of the field trial due to the rarity of this type of cyclist intersection.

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The importance of real-life impact

The fourth General Assembly meeting was held in Graz in Austria as autumn did its early entrance across Europe. Although chilly outside, MeBeSafe members began boiling of excitement to finally commence field trials and get their hands on some new data.

Picking up from the previous meeting, the teams had already seen promising results. Through simulations or small-scale testing, their nudges seemed to make a difference in traffic safety indeed. From now on, the data collected in the oncoming field trial would show just how accurate these indications are for the real world. However, given we receive data supporting those indications, how do we prove we'll actually have an impact in traffic safety?

The answer isn't straight-forward. The leader of the field trials, Mikael Ljung Aust from Volvo Cars, consequently kicked off the meeting with a workshop on the importance of translating our data to real-life impact. In brief, MeBeSafe set out to define the benefits of our nudges and their possible adoption in the real world.

From this, we can derive the impact; how many risky situations, fatalities and injuries can possibly be avoided? During the field trial, we are responsible for selecting the types of data that are anticipated to help us measure the potential nudge benefit. Once collected and analysed by each research team, the data will ultimately be analysed by another team lead by Jordanka Kovaceva from SAFER to solve the overall translation from data to real-life impact.

So which type of data would be suitable for each of our behavioural measures? This was the main topic throughout the rest of the workshop, which smoothly converged into the actual General Assembly meeting. The researchers from across the projects gave an up-to-date retelling of what's going on.

Olaf Op den Camp from TNO started off by explaining how his team had planned a car route on which they will check the effectiveness of their nudge. The nudge aims to support drivers in becoming aware of where cyclists might appear, and it consists of a low intrusive HMI (Human-Machine Interface) within the car. But will it suffice? The main question to answer is whether the HMI is able to direct the driver's attention to where we indicate it on the HMI.

The field trial will take place in Eindhoven, and the route includes 80 intersections where potential accidents could occur. It will be preceded by an initial test with a handful of people in order to understand how well the route works and if the results make sense. If it does, the complete field trial will commence with more participants. So, how will effectiveness be measured?

Speed could seem like a classic measure, but in this case TNO knows it would not work. If there is a car in front of an observed driver, it will affect the speed of said driver. Namely, they may drive at a slow speed because they are forced to. Then it won't be possible to interpret the driver's attention in intersections. Instead TNO will measure the direction and duration of gaze of the driver, as it has a stronger link to attention.

Pontus Wallgren from Chalmers presented how the Swedish cyclist nudge had fared in Gothenburg. The nudge aims to make cyclists more aware and adapt their speed ahead of dangerous intersections between cars and bikes.. As far as design goes, a version with flat white stripes across the bike lane has earlier shown the most promising results. Bikers seemed to slow down before an upcoming intersection, even when they expressed to not have actively noticed the stripes.

As part of the field trial, the nudge is already implemented at one of the riskiest intersections in this west-coast city. To analyse the effect, equipment has been set up to measure speed and trajectory of all cyclists passing this location. For a more user-centred perspective, cyclists commuting via the intersection have been asked to record their commute.

They are now eager to contribute with footage, trajectory and speed data. The data collection will be followed up with interviews to capture their thoughts on the nudge and bike lanes in

Illustration of the In-Vehicle Nudge

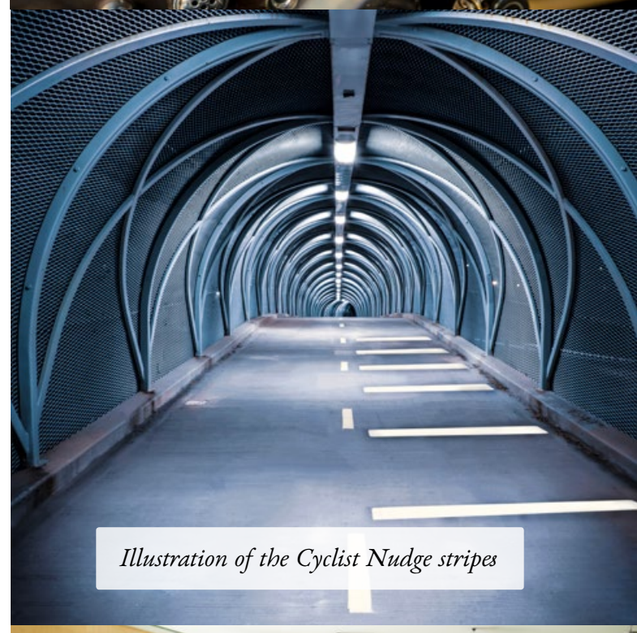


Illustration of the Cyclist Nudge stripes

MeBeSafe at the meeting in Graz

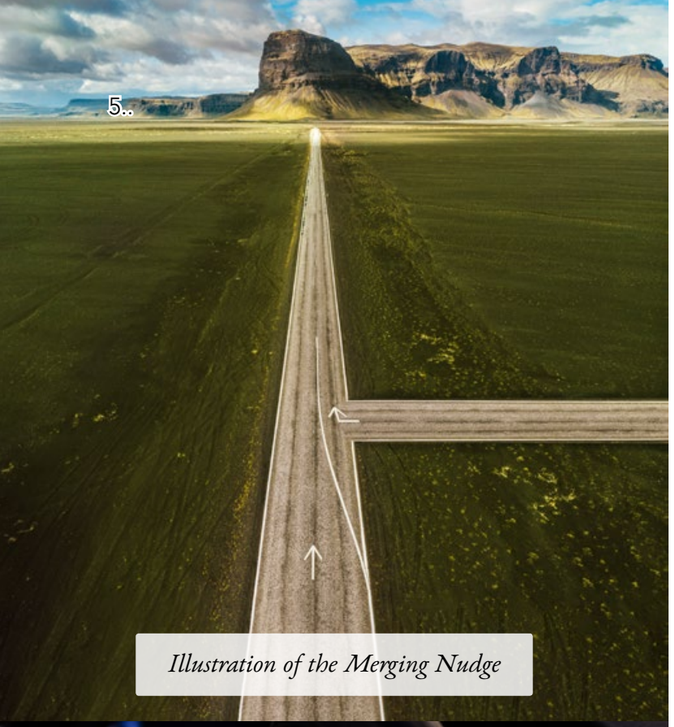


Illustration of the Merging Nudge

Illustration of the Coaching App

Illustration of the InfraDriver Nudge

general. Soon enough, the nudge will also be implemented at another risky intersection, followed by another round of recruitments.

Inspired by the cyclist nudge in Sweden, Olaf Op den Camp briefly described TNO's idea on how to implement the same nudge in the Netherlands. The starting point was to facilitate how bike lanes weave together, where both merging lanes show a high flow of cyclists. After thorough consideration, they will be looking specifically at double-lane intersections between bikers.

These can potentially pose a problem, for example, when a cyclist attempts to enter a bike lane where other bikers keep a high speed. In contrast with the implementation in Sweden, the team in the Netherlands will use the same type of nudge in order to increase attention rather than to decrease speed.

Next, Saskia de Craen from Shell gave insight into the details regarding the truck-driver-coaching app. The most interesting thing with this measure is how it involves peer-to-peer coaching, which is shown to be most effective in existing coaching literature.

Also, it is apparent why peer-to-peer came to be a necessity. Given that truck drivers have an incomparable amount of experience, it seems more credible to receive feedback from a fellow truck driver than top-down from a manager.

The coaching app is currently being improved on from the existing version. Now it is time for features which the team have been dreaming of implementing since the app was initially launched. This includes showing video footage for coaching purposes and a survey function among other things. As soon as the new version is online, the app will be distributed to selected truck drivers across Europe.

The goal is to decrease harsh braking by 50%, but the definition of what "harsh braking" actually is has shown to be something up for discussion. Nonetheless, if showing promising results in real life, Saskia asserts the app will likely reach beyond the MeBeSafe project.

Mikael Ljung Aust is responsible for two measures at Volvo Cars. Regarding the first one, he told how to cleverly overcome some complications of the adoption of adaptive cruise control (ACC) in cars. The concept of the measure itself is simple. It is an HMI where you see an ambient design that changes from non-orderly to orderly the more you use ACC. But in order to evaluate the app in-use, it requires the driver to activate the ACC. Following the findings from a previous study, they knew it is not as easy as it sounds.

In this study, drivers had been guided by the cars' limited voice-instructions: "Press the middle button". Not surprisingly, people interested in tech did it in no time, but people with low interest assumed the system was a full-fledged voice assistant and replied with questions such as "What do you mean with middle button?" The system wasn't able to reply back, and the users would not continue to activate ACC.

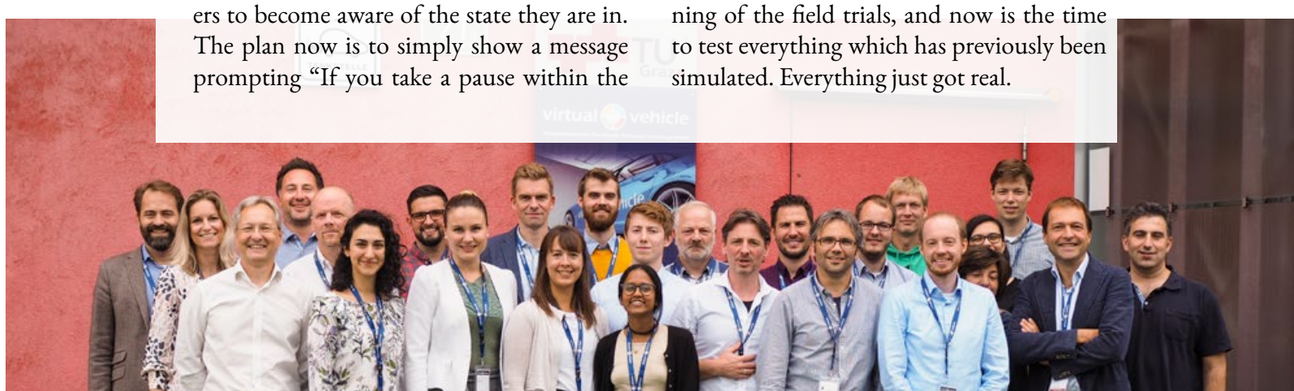
To overcome this complication, the team will conduct a Wizard of Oz study, i.e. people will believe they interact with a system while it in reality is a human. This way the team hope to coach even low-interest users into activating ACC, and subsequently be able to nudge for the continuous usage of it. For now, the app is installed in ten cars and the goal is to have a fleet of 50 in a few months. Along the way, the team hope to answer the question whether low-interest users will continue using ACC or not once they have been exposed to it.

The second measure from Volvo Cars is the In-Vehicle app nudging drowsy drivers to become aware of the state they are in. The plan now is to simply show a message prompting "If you take a pause within the upcoming minutes, you will have a movie ticket in your inbox". The potential of the app depends on whether we can find an incentive that will work over time. The team will commence by offering something that actually means something to people. However, what would one driver's reaction be if the incentives changed over time? Would the driver appreciate to receive a cup of coffee if named driver had previously received cinema tickets? The field trials will show us which road to take forward.

From here, Anna-Lena Köhler from ika took a right turn and gave updates on the nudge aiming to make drivers adopt a safe speed. This nudge works by lights sequentially turning on and off on either side of the road, giving you the impression of driving faster than you actually are. It has now been built onto a real road exit in Eindhoven and is currently being fine-tuned. How tangible the excitement was as this news entered the room! It actually is quite rare for research to take the leap from theory and papers to something so physical and close to reality.

The main focus will be to collect speed data over time and see how drivers are reacting. An elegant detail about this particular nudge is that it will only be activated if the driver's speeding behaviour is considered risky. As such, the nudge will be used only as much as needed.

Ending this General Assembly, only as much as needed could summarize the essence of all MeBeSafe's nudges and measures. Here in the middle of Europe, underneath a duvet of autumn leaves, we have now established our excitement. We are at the beginning of the field trials, and now is the time to test everything which has previously been simulated. Everything just got real.



Can you be nudged to look the other way?

MeBeSafe has developed a nudge in the car to increase the driver's attention when cyclists approach. The nudge has now been built into a vehicle – but can we make sure that it is really working?

A driver approaches a dangerous intersection with blocked view. There may or may not be cyclists hidden somewhere out of sight, who could run out just in front of the car. MeBeSafe wants to make the driver more attentive to this threat by lighting up a nudge in the car.

A stylized image of an intersection will show up, with an indent showing from which direction an unseen cyclist is most likely to approach. This information will be based on historical data for now, but MeBeSafe is also developing the technology necessary to spot cyclists in real time.

This seems really good in theory – but will it work in real life? Could such a simple nudge really help to refocus the attention of the driver? A simulator study made by CRF showed promising results – but now it is time for the real roads.

For the nudge to be a success – it must work no matter who's being subjected to it. Therefore, a good mix of people with different gender, age and background are being recruited to come and drive the car as a part of the Field Trial. And the first challenge starts already at this point. Should the drivers know what they are about to test? Olaf Op den Camp from TNO has not yet decided upon this.

"If the drivers are naïve, we will capture their actual first-time reactions, which provides a fair comparison with the previous simulator study. But if they know about it, maybe we could simulate how they would behave in the long run when they are used to the nudge? I'm however leaning towards the first option."

The nudge should work particularly in intersections where the view of crossing traffic is blocked. It therefore makes sense to test it in an area with a lot of such situations. And fortunately, there are perfect areas for this in the Netherlands.

"A lot of people moved to Eindhoven hundred years ago, so huge areas of small houses were built – very close to the streets to save space. Views around the corners are blocked all the time, so this is an ideal place to test the nudge" Olaf asserts.

The drivers will be taking a trip around this tight city, while the researchers observe their behaviour. Normally, you would measure speed or braking in order to assess how safe you drive and if collisions can be avoided. But speed or braking is not the target of this nudge – it aims to make an impact already in directing the attention. And one way to asses this is to actually measure where people look – by their gaze.

"Of course people shift their gaze all the time, but if we can move the overall distribution of gaze towards the side that we nudged for, it seems that we have succeeded", Olaf explains.

But what if the drivers are cautious good drivers and choose to look in that direction on their own most of the time? How can we know if it was them or the nudge that was responsible for the gaze patterns? One way to find out is to use so-called false positives.

"The false positive is a very powerful tool. It means we light up the nudge out in the open where there's no reason to look any extra in a particular direction. If they still look more towards that direction, we know that it was the nudge that made them do it", Olaf op den Camp proclaims. And if the nudge will work to redirect attention, it will then make people look at the right spot.

Behind this nudge lies the knowledge of which intersections are dangerous, which is built into a hazard model that the nudge makes use of. Of course, it is not feasible to model this for each single intersection around the world. Traffic is moreover very dynamic, and no two situations are alike. That's when a dynamic model developed by Cygnify and TNO comes in. It contains equipment to scan the surroundings in real time, detect cyclists and predict if they are about to cross in front of the car. This will however take a few more months to complete and is expected to be tested in a FIAT car after that.

But the principle is very much the same. If people are nudged by the rather simple static model, they will also be nudged by a more sophisticated future model. And this model is not only good for nudging – it could also play a crucial role in a more automated future.

"This model can not only be used to determine when to nudge a driver. It could also form the basis for how a self-driving car becomes aware of cyclists –and then influence which decision it will make" Olaf proudly states.

So in the end, this trial could actually lead to two potential applications. Both the obvious of nudging drivers to change their gaze pattern and detect cyclists. But also as a future way not to nudge you – but to nudge your car.

The nudging car on road to completion

In the future, your car could nudge you to drive safer. MeBeSafe is developing a nudge in the car that scans the surroundings and helps you make the right decisions. For the first time, all the components are being put together.

A lot of accidents occur in intersections. Especially between cars and bikes. Car drivers often fail to spot an approaching cyclist, and the accident is a fact.

MeBeSafe envisions a car that can nudge drivers to reduce their speed and direct their attention towards the cyclist when they approach such a situation. That is, when they approach a risky intersection.

This idea has been developed from a lot of angles, and is finally about to be built into a car. But for this to work, the car needs to know when an intersection actually is dangerous.

And how could the car possibly know that? Well, by using lots of input data and advanced calculations, of course! There are two ways this problem can be tackled. The car could use previous assessments of how dangerous each intersection is – and nudge the drivers to get more aware when they approach a known red spot. It could also monitor the entire situation and spot the cyclists first. Both of these approaches will be used.

In the first test phase, only pre-made assessments of each intersection will be used. There is of course a lot of information about where accidents happen, so this would work. But only in general terms. Such a nudge can make drivers more likely to reduce speed and look for cyclists each time they approach a dangerous intersection – but not even more so when a cyclist is actually approaching.

Therefore, a second step will be added that also checks the actual surroundings for what is happening in real-time. All road users will be monitored, and an immediate risk will be calculated – not only just an average risk for each junction. Bram Bakker from Cygnify is one of the persons working with this, and he has found a lot of challenges.

"The first pre-made model is fairly simple. We know when the car is about to enter a dangerous intersection. But a lot of components have to work together for the second immediate step to work" Bram explains.

To get an immediate estimate of the risk, the car will take information from cameras filming the situations, lidars scanning the surroundings and IMU-sensors measuring the orientation of the car.

Using these inputs, a complete model of the surrounding area will be made digitally. In this model, all relevant objects will be identified. And when it is known which things are cyclists, pedestrians, cars or perhaps flagpoles, we have to model how they will behave.

Will they move, and then in which direction? Using the data on how they have moved previously and how such objects usually move – it is possible to get such a prediction. And this prediction will form the basis for a risk assessment; how big is the risk of an accident occurring?

The two MeBeSafe partners TNO and Cygnify have built modules that can do all the parts of this complex workflow, but they have never been tried together before. If the driver is to be nudged as intended, the underlying modules have to talk to each other fast and efficient.

To test all of this, TNO and Cygnify hooked up their modules together to see how it would work. The result from one module is necessary for the next to perform its calculations, and this goes for all of them. So this really had to work. At first, a lot of data was generated to simulate the first input into the first module, just to ensure the flow. And this proved to work remarkably well. The data could of course be different in a real car with real sensors, so the system was put up in a car as well. And fortunately, these results were just as positive as Bram Bakker is.

"It's really exciting to see that all of these sophisticated hardware and software components can get together and work so well in a car. And it's even more exciting to see that we are almost ready to try them in the field!" Bram exclaims.

Only a few tweaks have to be made to ensure a fully seamless interaction between the two systems. This is a step that must be made, but an extremely small step compared to what already has been done. And as soon that has been done, the functionality of the car will be tested.

Not only if the physics behind the nudging works, but also if it can really nudge the drivers. The first model with pre-made data premiéred late last year, and the full instantaneous one is on due course to be tested. Bram Bakker is really happy how this process has worked out.

"I'm so proud of the level of sophistication we have managed to achieve together. Not only in terms of scientific challenges, no, but also in the technical 'we need to make this work in an actual vehicle' challenges. Theory and practice coming together in the best possible way"

Cyclists soon to be nudged

Cyclists will be nudged to adapt speed before dangerous intersections. This decision was reached after the MeBeSafe cyclist team met up in The Hague before the Field Trial began.

Bicycle after bicycle passed. A seemingly never-ending stream of bicyclists gushed past outside the window at the SWOV building in The Hague. The MeBeSafe cyclist team had got here to make a decision on which nudges to use on cyclists. And it must be said that the team was close to the cyclists in more than one way.

A lot of progress has already been made. All nudges have been tested and evaluated in close collaboration with cyclists, and it was now only a matter of which ones to choose for implementation. Chalmers has made a lot of tests on how to make cyclists adapt their speed before dangerous intersections by nudging techniques. And the tests came to bear fruit, as Chalmers' flat-stripe nudges seem able to combine the seemingly impossible two; reduce speed and reach universal cyclist approval.

"This is much better than we ever could have hoped for" Pontus Wallgren from Chalmers cheered, *"The effect on speed is remarkable, and everybody appreciates it – what else could you ask for?"*

SWOV and TNO have on the other hand investigated how nudging could alter the trajectories of cyclists. It seems like a few visual lines could really help when cyclists coming from one direction turn into a biking lane heading in another direction.

"Nudging cyclists to merge together smoother can really both increase safety and affect the flow on the biking lanes", Matin Nabavi Niaki from SWOW happily exclaimed.

The initial plan was to evaluate the same nudge in the same way in Sweden and the Netherlands, to see if equal measures would work across national barriers. And that would indeed have been interesting; to see if

cultural differences would alter the intrinsic behaviour of the nudges. Incidentally, cultural differences proved to throw a spanner in the works in a wholly different way.

The speed nudge will reduce the speed of cyclists when it is absolutely necessary; before a car-bike intersection with blocked view where accidents have regularly happened. This scenario can be found in Sweden, but actually not in the Netherlands. Dutch bike traffic is just so full of bikes that it is totally impossible to reach any speed. Moreover, biking lanes turn a bit outwards before car intersections, reducing the problem with speed and making it difficult to implement anything else.

The trajectory nudge would on the other hand help cyclists merge when biking lanes intersect, which is not really an issue in Sweden. Swedish biking lanes are rarely separated from other traffic, and it is very unlikely to find a busy bike-bike situation that proves to be dangerous enough for a nudge to be set up. However, the trajectory nudge was made for scenarios where two single-lane tracks meet in a T-intersection. It is based on narrowing down the highway lane from the side, to give some free space for the cyclists entering from that side. A lot of searching was conducted, but no suitable intersection was found. And this nudge will not really work for a T-intersection with traffic in two directions.

MeBeSafe will therefore test the only combination that makes sense in each country. And that, of course, makes sense. The stripe nudge will be used for both Swedes and Dutches. But whereas the Swedish aims to reduce speed in car-bike situations, the Dutch one aims not for speed but for increased attention when bikes intersect other bikes. This will make the nudge relevant everywhere.

Both countries aimed to use several locations to verify that the results are not only a product of one single place but rather an effect of the nudges on their own. As the speed nudge relies on illusions, which are very hard to avoid, it has a high potential to work in the long term. However, this naturally needs to be verified. The nudges will therefore be up for several months to really monitor the effect over time.

To verify that the speed nudge will work, you cannot only look at the average speed at a certain location and see how that changes. Cyclists are far too diverse in terms of speed for that to work. To make sure that it is the nudge that alters the speed, each cyclist's behaviour must be checked.

More specifically, their actual speed decrease will be checked. How many percentages does each cyclist reduce their speed. To know this, their maximum speed before slowing down must be known as well as their minimum speed. And to know that a certain speed is max or min, we must measure their entire speed-location behaviour.

This would not had been possible just a few years ago. MeBeSafe is using the latest tech in camera detection to get the full speed-location curves of all cyclists, cars, scooters and pedestrians; simply from taking up a film of the intersections. Each frame is then analysed by a computer, that will detect which moving pixels make up which type of object. Thanks to this novel technique, it is possible to know everything that happens. MeBeSafe will therefore be able to pinpoint exactly when and how much the nudges work.

The meeting in The Hague proved to be a success. It was time to leave the building and venture out to find a place in the everlasting stream of cyclists outside. After just two months, real lanes were fitted with the nudges of MeBeSafe. Nudges that are being evaluated from every single angle, to assert their functionality down to the most minute aspect. Nudges that are made to make traffic safer. Nudges that could shape the future.

Nudging the ITS Community in Eindhoven

Eindhoven was the place to be in June if you are interested in the future of transportation. MeBeSafe was of course present and cradled a hefty number of bigshots into the cosy world of nudging.

Some peculiar white stripes ran across the blue floor in an aisle at the ITS fair. What could this be? They seemed to be heading towards one particular booth. A booth about nudging and coaching. Now, this seems very fitting as the stripes more or less appeared to nudge people into this booth bearing the banner of MeBeSafe.

A great deal of visitors had never heard about nudging and wanted to know what this remarkable phenomenon was; the phenomenon that had just made them subconsciously move towards this one booth. Others were instead highly familiar with the concept but had never seen it applied to traffic safety before.

All sorts of beings could be seen grazing the booth, from engineers to developers and Ministers of Transport. Germans, Australians, Russians, Singaporeans and a whole lot of others all got fed with the good news of nudging. And they all appeared equally amazed when they got to engage with the enchanting researchers manning the booth.

Visitors were not only nudged by the visual stripes or by the immersive video running on a screen to summarise the project. They could also experience a truly unique MeBeSafe nudge in real life. MeBeSafe's partner Heijmans organised excursions to a road exit just some blocks away. This is not an ordinary road exit, but a road exit with rows of lights built into the ground.

The light could start moving between the lights depending on your behaviour on the road. This novel fabrication was finished only mere days before the conference. More than a few visitors made the trip and they were not disappointed.

Indeed, most of them wanted to know beyond this one nudge, and experience even more of what MeBeSafe has developed.

Except the obvious question what nudging really is, the most common enquiry was of course if the nudges really work. They seem so simple, so could they really affect behaviour; especially more than once, when you have learned what they want you to do? And in MeBeSafe's case, it really seems like they can. The nudges have been tried with really promising results so far, and will be evaluated further for even longer periods of time in the real world.

In the midst of all this lies another soft measure; namely coaching. MeBeSafe is developing a novel way of coaching truck drivers. This coaching is based on an app for truckers. Driver apps providing statistics of course exist in vast quantities, and many of their developers were actually visiting the MeBeSafe booth to see this particular app in action. And none of the others used total data integrity; not sharing the stats with a boss; or letting colleagues coach each others' as equals, as MeBeSafe is doing. It is not surprising that many conversations about future connections were held around the booth

Several hundred people had already spoken to MeBeSafe, and a last rush was made on the final day when Anna-Lena Köhler made an official presentation in one of the Conference Seminars. MeBeSafe was no longer an unknown name seated in the outer rim of the conference halls.

People were seen reading MeBeSafe newsletters all over the place, and nudging was discussed both here and there. Delighted with the enormous outreach, the researchers packed their bags and ventured home; safe in the knowledge that nudging and novel coaching will have secured a bright future in the field of traffic safety.

Will a good nudge affect workload?

A nudge could reduce speed in two main ways. Either because it triggers an automatic response to reduce speed, or because it takes up so much attention that it makes it impossible to keep the current speed. How do we make sure that it is the former?

Speed is sometimes very important. When a car leaves the motorway on a curved exit, then high speed could mean sliding off into the bush. When a car and bike are about to cross each other's way in an intersection with blocked view, high speed could mean failing to spot one another in time. MeBeSafe is trying to solve these problems by nudging techniques.

A contrivance called the InfraDriver nudge will help drivers to reduce their speed at motorway exits by using lights that move. Another one called the Cyclist Nudge will help cyclists adapt their speed before intersections, and the third one called the In-Vehicle nudge targets drivers in the same scenario.

It is tempting to say that the nudges are a success if they reduce speed. But that's not the whole truth. If the nudge takes too much of the drivers' attention, they might still happen to crash into something. It is therefore of utmost importance to evaluate the nudge in terms of attention and workload.

Gothenburg; on the barren shores of West Sweden. A cyclist runs down the lane. She has a camera on her head finding out in which direction she looks, and another one on her bike to capture her speed and trajectory. She is part of Chalmers' first major nudge study, made by Pontus Wallgren and Victor Bergh Alvergren. This early test served to measure the effectiveness of various nudges in terms of speed as well as attention.

And the results were interesting indeed. Two nudges were found equally effective in reducing speed. The first one worked by seemingly narrowing down the lane due to the sidestripes moving gradually inwards. The second nudge had an array of stripes running right across the road, getting closer and closer together. In terms of speed, both made the cyclists slow down a large amount. But there was one major difference.

The head camera measured how much the drivers turned their heads around and looked towards the left and right before the intersection. More or less, how attentive they were to the surrounding traffic. The narrowing nudge seemed to make them look much less to the left and right, while the stripes found no such effects. This exciting discovery made selection of a nudge for the field trials very easy.

"The narrow nudge was not really a feasible alternative. Although appreciated by cyclists and effective in reducing speed, it seems that it only reduced speed because it demanded attention. And the pattern was the same even if the cyclists were not aware that they had seen the nudge." Pontus Wallgren proclaims.

The very same reasoning goes for the InfraDriver nudge, but here attention was treated in a rather polar way. Drivers were recruited to drive around in a driving simulator at ika where they eventually would encounter the nudge. But they were not only to focus on driving – no, they were given another task that they should do at the same time.

They were for example told to look at an in-vehicle screen and try to find the largest circles among other peers. All the time, their attention was identified by measuring how well they succeded. So their direction of attention could be known all along the trip.

Naturally, drivers put a lot of effort into their secondary task when driving at a normal road. But when the nudge appeared and the lights turned on – their attention seemed in many cases to be moving away from a secondary task. The nudge then clearly seemed to redirect their attention to the nudge and to the road. This remarkable finding indicates that when a driver is doing something else, the lights could make them more aware that something is going on around them.

"This is interesting, but the most interesting thing is not that the nudge works – but how it works" Anna-Lena Köhler from the ika states. *"It has an effect on speed, but it is rather small. Some people might misinterpret that to mean that the nudge is not working. But that is not the case. Since it makes people more aware of the situation, it is instead highly likely that it really works."*

So while the design for the cyclist nudge was chosen because it did not take any attention away, and allowed cyclists to look around for others who might cross the intersection – the InfraDriver nudge was found good because it ***did*** take some attention. It showed you how you should drive, but also directed attention away from other secondary tasks to the real world. And in a curved exit, with no crossing traffic to be spotted, that is of course the main focus.

So a good nudge could very well take some attention and workload – if the situation demands it. And in terms of attention, the two nudges really seem to serve their purpose. One takes no attention, and the other directs it. Right towards a safer future.

Transverse stripes

Lane narrowing

InfraDriver Nudge

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MeBeSafe nudges literally on the road

Traffic rules only work if people choose to obey them. But the traffic environment could instead be redesigned so that good choices are more likely to be made.

MeBeSafe has designed several so-called nudges to make traffic safer, and they are now ready for the roads.

"There it is! The lights are turning on – we're getting closer and closer to it. And.... It works!". Stefan Ladwig, coordinator of the MeBeSafe EU project, is delighted. MeBeSafe is all about nudging for safer traffic, and the first so-called nudge has just been put on a road.

Car after car drives down the road while specially adapted roadside lights flicker on and off. And the drivers seem to react.

This mysterious light-switching-device is one of the things MeBeSafe has produced to make traffic safer. At present, the classic way of making traffic safer is to prohibit all dangerous behaviour.

But rules and laws can only work if people recall them and actively choose to follow them. If subjected to strict surveillance and tough enforcement, most people will likely obey – but that means we have used fear to control people. Why not give them the option to make a safe choice on their own?

MeBeSafe therefore makes use of the ever more popular nudging approach. A nudge is an alteration of the surrounding world that aims to make it more likely for you to take a good decision That said, you will always be free to make any choice you want – since a nudge is the total opposite of a compulsion.

This positive approach is what MeBeSafe will be taking to the streets. And the streets are a dangerous place indeed. A lot of people are still dying or getting injured there every day.

Many measures have been designed and implemented to help us, but most of them just try to avoid or mitigate a crash when the situation has already become critical or when the crash has already occurred.

However, each accident is the result of a chain of previous events. If good, safe choices were made throughout this chain, many accidents would never even get close to occurring. This is the aim of MeBeSafe.

Decreasing the danger of intersections

Intersections are a red spot in traffic. So many serious accidents occur in this seemingly safe haven, and mixed intersections between cars and bikes are high on the list. In fact, eight out of ten accidents between cars and bikes happen here. The scenario usually follows the same predictable pattern: car driver and cyclist approach intersection, car driver and cyclist fail to spot each other in time, and car driver and cyclist collide. To make this situation less dangerous, both drivers and cyclists need to act.

It would make total sense if all road users approached a dangerous intersection at low speed and with high awareness. Low speed makes it easier to spot one another in time, and also to brake when necessary.

MeBeSafe has found that flat stripes running across the road can help. These stripes cannot be felt, but they get progressively closer together. And as they get closer and closer together on your approach, your instinctive perception is that you are going faster and faster – so you slow down.

The initial results actually indicate a remarkable combination of effects. The stripes seem to generate a significant speed reduction combined with very high appreciation by cyclists.

However, a similar effect has to be found for cars too. MeBeSafe has therefore made use of another novel idea. By placing rows of lamps along both sides of a road, we can make them light up one after another in sequence. This pattern makes it seem as though the lights are moving towards you.

As the surroundings appear to move faster, this naturally makes you more prone to slow down here too. But the cleverest thing about this system is that the lamps only turn on if your speed is inappropriate.

More obvious nudges

These nudges are both rather discreet, and you may not give them a second thought. But nudges can be much more obvious too. MeBeSafe has developed such a nudge for installation inside the car – and it helps you spot cyclists.

An ideal implementation would be a green line projected in the windscreen that seems to follow the road. Whenever a cyclist appears, the line turns red and a notch is projected to show where the bike is coming from. When this system was adapted from a simulator to a real car, the line was converted into an icon in the instrument panel showing the very same graphics. This icon has also been found to have a good effect on focusing the driver's attention.

By using apparent nudges within the car, a whole world of possibilities opens up. There are already coffee cup symbols in instrument panels that light up when the on-board system detects that the driver is tired. However, such symbols are usually not enough to prompt an actual reaction.

MeBeSafe will therefore experiment with rewarding the driver for taking a break. Would the tired driver be more prone to stop and rest if he or she got a free cup of coffee from the nearest café? Or a cinema ticket? Such an incentive scheme could educate the driver and thereby work in the long term.

A new way to coach drivers

Another way to make an impact over time is to use coaching. MeBeSafe is exploring this for truck drivers. Truckers live on the road. They are the experts and very few people have the knowledge needed to coach them. The only people who actually can are their fellow truckers, but they don't have the time to come along and see how their friends drive.

So MeBeSafe has invented an app for that. The app tracks a trucker's driving, and all this data belongs solely to the driver. Nobody can monitor them or force them to give away the data. Only the phone with the app will analyse the data, and suggest when two peers should meet and what they should discuss at this meeting.

All of these solutions have been thoroughly tested in multiple pre-studies to ensure that they are the best possible solutions to date. And now they are being driven onto the road. MeBeSafe has built all of this on real roads, in real cars or for real phones.

Over a period of six months they will be tested by people in everyday situations to obtain precise statistics on how they work, for whom they work, and how they can make the streets safer.

Nudging drivers only when necessary

When you leave a motorway you should keep a safe, low speed – and nudging could help you reach this. But such a nudge would most often affect slow drivers as well – and slow driving close to a motorway could be dangerous. It's time for adaptive infra-nudging.

Traffic has become a lot safer over the years. Roads are getting better and cars are getting smarter. But there are still some places where danger lurks in the shadows. Motorways are generally thought to be very safe, and that is true in the large terms. When you are driving on a motorway, accidents are normally very rare because the road is built to encompass the speed.

But when you leave the motorway, you run into roads not built for the same speed. Yet, in the often curved exits you could still keep a fair bit of your rapidity. And curves and speed could mean fatal consequences.

Reducing speed when leaving a motorway could therefore be a lifesaver, and nudging is a very feasible alternative. That is, if you are going too fast. But what if you are already driving slow, maybe far beneath the maximum speed of the motorway? If you would reduce that slow speed even more, you would have an ever increased risk of getting hit by a speedster prowling in from behind. So it is therefore essential that a nudge could be targeted to specific groups. And that's where the main concept was born.

"Road marks are permanent. If they are there affecting one car, they are there to affect them all. So we started to explore other ways of giving away signals from the infrastructure." Anna-Lena Köhler from ika at RWTH Aachen explains.

So the MeBeSafe team got together and started to ponder. The nudge would have to work over a distance – and not only at a single point like some kind of road sign. Speedsters should get help to reduce their speed during the entire exit. But the contraption should also be able to switch on and off. Maybe it could move alongside the car?

"We had a lot of ideas on how to do this" Anna-Lena states "*And many of them could be made by using projections on the road."* Projections was indeed a sweet spot for many of the different teams in MeBeSafe, as they

could provide new exciting ways to convey the message. But two things served to throw spanners in the works here. First the technical limitation. If a projection is to be seen in daylight, it has to be stronger than the sun – and that's very hard to do. But even if that could work, it would most likely be used for intricate and unusual images – not normally seen on the road. This could take up way too much attention from the drivers that they had to process. It had to be simpler.

That's where the ingenious idea was born. Why not use roadside lamps to nudge people? Lamps are truly omnipresent in traffic, and will most likely not be as distracting as a totally new thing. A long row of lamps could be placed along the roadsides of the exit, and the lamps could be lit up to make it seem as the light itself is moving. And lights moving towards you could give an illusion that you are driving faster than you are. This seemed like the perfect solution.

"We set up a real road exit in our driving simulator in Aachen, and tried three different ways that the light could behave" Anna-Lena excitedly exclaims. *"First, the lights were lit up as any regular light, secondly they were blinking and thirdly moving towards the drivers. A lot of different colours were tried, and we also measured how much attention it took away from people."*

The simulator studies were a success. They found that drivers were indeed affected by the nudge. The results were further verified by trying an opposite mode; would moving the light away from the driver increase their speed? Drivers got to experience this and were interviewed about it – and it really seems that it would. So the lights were indeed able to influence the drivers' speed. But all of this naturally had to be tested in a real world as well.

The construction company Heijmans succeeded in bringing the nudge to the roads, in close collaboration with ISAC and ika. After little more than a year, the idea had actually been brought to life. And now the work has just started. A sophisticated system built by the ISAC monitors the traffic from above and decides when the nudge should be on and off, but it also collects the data on how everybody has fared.

The data will show if there is a difference in behaviour when the nudge is on or when the nudge is off. Soon we will be able to know how well the transition from idea to simulation to reality has worked. And if the future can be as bright as the nudge itself.

The people of MeBeSafe

MeBeSafe would be nothing without all the wonderful people behind it, devoting their work and soul to get the best possible results. Read what some of them have to say, and see the full interviews on our website or social media.

I'm very enthusiastic about the Peer-To-Peer Coaching. Coaching is a popular countermeasure but the results are often a bit disappointing. But MeBeSafe have taken a very good look at previous knowledge, and put the best practices together so I have very high hopes!

We are developing many interesting measures, so a few should really be able to change people's behaviour. And hopefully they will save lives.

Saskia de Craen
Shell

The project is big and in the beginning quite abstract. Now that we've built a demonstrator it just gets so concrete.. We have something in the infrastructure that we can actually try out.

Throughout the project we always get newer and newer ideas where this entire field could go to. There is very much potential for new research! So instead of punishing drivers, lets go for nudging that has a more long-term effect!

Adrian Fazekas
ISAC, RWTH Aachen

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