MeBeSafe News

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Nudging and coaching for safer behaviour

MeBeSafe will develop and test solutions to nudge car drivers and cyclists towards safer behaviour in common traffic situations with an elevated risk. The project will also assess the impact of coaching.

There has been a lot of progress in helping drivers prevent risky situations from turning into crashes, and in reducing the complications if a crash should occur. However, less effort has been invested in preventing risky situations from occurring in the first place.

An accident will happen when safety margins are reduced to zero. This is not a common event, no, an average road user will never be involved in a serious traffic accident, or even sustain a minor traffic injury.

The actual safety margins encountered in everyday traffic usually vary between ample and very narrow. Road users are however rarely aware of their safety margins, except in a very few cases of "near-misses". For over 99% of their time in traffic, road users receive no feedback on whether their perception of risk is accurate or whether their safety margin is adequate.

MeBeSafe has therefore chosen to focus on road users, as road traffic is far more dangerous than travel by train, plane or ship. Most road users are also amaeurs in getting themselves from A to B.

The project will develop and validate nudges that can make drivers and cyclists behave safer in dangerous traffic situations. That is, to make the road users preserve adequate safety margins to a higher extent.

Nudging has been on the rise for the last couple of years for very good reasons. Nudging measures still allow people to choose freely between different alternatives, and the choice is just presented in a way that make it more likely they will choose the "best" option.

This is in contrast to forcing measures that take away the choice altogether or make the "wrong" choice very hard to make, as well as in contrast to informative measure presenting factual information without seeking to guide the user's choice. Nudging can help people, without taking away their freedom.

Publishing the amount of calories for various cafeteria choices is an informative measure. Not selling sugary drinks is forcing. Positioning the healthy options at eye level and the fatty options much lower is nudging.

A nudge in the car to increase attention

It is not always clear if an intersection is dangerous or even if there is an acute risk of hitting somebody. Several in-car nudges have been developed that could help drivers increase their awareness.

Many accidents occur in intersections. There are of course statistics on which intersections are most dangerous, and it is even possible to use video cameras to locate crossing traffic in real time before an accident happens. This is potentially life-saving, but the information must somehow be transmitted to the driver if it is to make any sense.

One way of doing this is to nudge the driver; still preserving their freedom of choice. Early ideas about blocking the accelerator pedal were inevitably scrapped for the benefit of the nudges. The focus has instead been on presenting the information to the driver, so that they could make an informed decision.

Now wait, you may ask yourself. Informed decision and nudging; how does this add up? Well, it is certainly a bit away from the traditional subconscious nudge; the so-called type 1 nudge. Type 1 nudges appeal to subconscious mechanisms outside any active control and nudge humans into making a better decision without them knowing it.

What is used here is instead a type 2-nudge. A type 2 -nudge focuses on the conscious decision making, and makes a good decision more likely by providing relevant information. Marie-Christin Harre from OFFIS was one of those responsible for the nudge design, and is totally aware that this border is discussed.

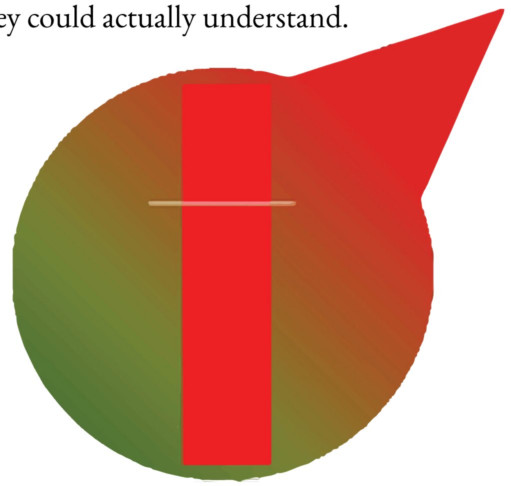
"The ways you present this information will always be quite similar to an alarm. However, by explaining the situation longer before anything happens, we give the drivers more time to act and think on their own. An alarm may be presented just 1 or 2 seconds before the potential impact, whereas we start the nudge 5 seconds before"

There are three different designs for how such a nudge could look, and not so long ago there were six. They are all the results of an exploratory workshop and were all shown to potential drivers for feedback.

Most of the nudges relied on the type 2-principle of presenting the information directly, but there was one more abstract and nudgy design. It consisted of a colour-and shapeshifting circle. When a dangerous situation approached, it morphed away from the round smooth design if the drivers were going too fast. This idea was thought to appeal to humans' love for smooth round shapes, but it didn't really hold up in the end.

The morphing circle was not really understood; neither regarding what it meant, why it changed shape, nor what could be done to change it back. So no matter how much the drivers would want the smooth round circle to come back, they would not be able to subconsciously act upon it and make it round again.

Instead, it would evoke some weird complex of subconscious stimuli wanting to make the circle round, which in turn would have to appeal to active thoughts. No, it was clear that the people preferred the nudges they could actually understand.



The morphing circle presenting a dangererous situation.

It was also clear that drivers did not want nudges distracting them or obstructing the view, which is certainly a fundamental aspect in MeBeSafe. One design consisted of an intersection symbol mounted in a head-up display right over the real intersection, and this was not well received at all.

The most preferred nudge was actually rather similar, but yet fundamentally different. It is also found in a head-up display, but more moulded into reality.

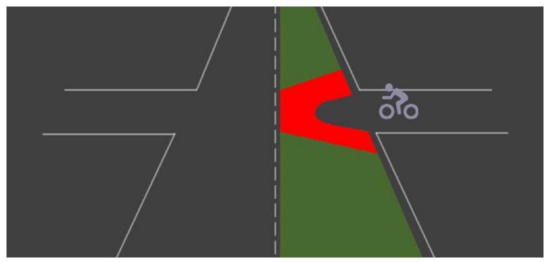
Whereas the floating intersection symbol just hovered around over the intersection, this nudge follows the perspective actually seen. It consists of a green line following the road over an intersection, where it may turn red if the intersection is known to be dangerous and the driver is keeping an elevated speed. If a crossing cyclist appears, a notch in the line will appear from the same direction that the cyclist is coming from.

The very same illustration can also be mounted in the dashboard, which in fact is the second nudge. The dashboard could also be used to show a simple symbol of a red-coloured intersection, potentially indented for approaching cyclists. That is the third nudge.

Even though dashboard communication was less preferred and is easier to miss, one of these nudges may nevertheless end up as the finalist. It is as of yet very difficult for the car to analyse the surroundings in real-time, and then render the line precisely where the road is running. A single small error and the line will not follow the road, which most likely will make the nudge much less appreciated.

In a car simulator study, everything can of course be tried, and this is what is going on at the moment at CRF. All three designs will be evaluated in a simulator, and the results will then form the basis for the field trial implementation. Marie-Christin Harre is looking forward to the results and has a plan what to do.

"We believe that drivers will still prefer the head up-display image of an intersection, which we may not be able to test in a real car due to current technical restrictions. However, if we use the same image on the dashboard and test it that way and it works, we could say that when the technology is ready there is an even better alternative in waiting".



The intersection warning as to be shown on a dashboard

Nudges in a simulated real-life road exit

The road in front of you may look real, and it actually is. Only simulated. This makes it possible to evaluate infrastructure nudges on a real location without actually venturing out into real life.

It is totally possible you will get something of a déjà-vu experience when driving around in this simulator. Only a few trees differ from a real-life location, which is the exact location where this nudge is to be tested in real life later on.

IKA in Aachen built a complete model of the surroundings to be able to make a lot of tests on the real location without actually rebuilding anything or potentially bringing anybody into danger.

And indeed, the simulator assured that none of the 54 test persons were in any danger. Except in danger of being tricked. The participants did not know that they were about to be nudged, as this could have affected the results. Instead, they were told that the test was about distraction, and were given a distracting task to do while driving. Naturally, this task was designed to end just before the nudge appeared. Additionaly, they were also told to go speeding at 100 km/h up until they felt it necessary to slow down in order to stay safe. Such an approch may seem rather odd, but it is because this particular nudge is only active when the driver is speeding, and aims to reduce their speed. Stefan Ladwig from IKA describes the situation.

"We don't want to slow down drivers who already are driving safely. This is why we will use lamps to nudge them, as lamps can be turned on when somebody is speeding and turned off when somebody is driving safe".

And in order to get enough data from the simulator study, all drivers were turned into speeders and therefore encountered the nudge. Or actually, they encountered the nudges, in plural. Two different variants of light nudge were used, both based on rows of lights being placed on the roadsides. The first variant simply consisted of every fifth lamp being lit, whereas the second involved the light travelling towards the driver in 50 km/h. This movement is believed to create an illusion of travelling at a higher speed. And it seems to work.

Both nudges reduced the average speeds by a couple of meters per second and made the drivers brake earlier, without having them devote all their attention to the nudge. And just as expected, the moving lights were most effective. The speed reduction is significant, but less than what was expected. Anna-Lena Köhler from IKA explains why this could be.

"The simulator has a wide field of view to all sides, even in the rear mirrors. But it is always fixed to the ground and does not move. Maybe people did not feel that the situation was that dangerous, and did not slow down as much as they would in real life".

But actually, too large speed decreases may not be good either.

"Of course, we do not want people to just hit the brake and stop on the motorway exit. Now the light seems to guide them more safely through the exit," Anna-Lena Köhler says.

And to make people feel safe and comfortable with the nudge is a top priority. A second part of the simulator study was more focused on driver acceptance. It showcaseed different colours of the lights and made the drivers rate them. Red and orange were found to be the pick. There was initially an idea of having the lights glow red when speeding, and then changing them too a positive green when the drivers reached the desired speed, but this was found to be detrimental. The drivers actually associated the colours with traffic lights, and believed that green lights meant they should speed up again. Quite the contrary to what it actually should mean.

It is not yet known exactly why the nudges work, or if they would work in more complex driving situations, such as having screaming children in a car. Topics like this will be addressed in further studies yet to come. Both that and the studies made provide invaluable input to the development process; input that would have been impossible to get without a simulator. But naturally, it is not only the results from the simulator that count in the end. It is the results from real life. And this light nudge is actually soon to be put up for tria. So soon we will all get to know how it adds up in the real world.

The simulator set-up used in the study.

Spotting cars by their temperature

To implement the light nudge in real life, cars have to be spotted by a computer that could turn the nudge on. It is common to use a regular camera to identify vehicles, but this approach does not work at night time and may lead to privacy issues due to filming the registration plates. MeBeSafe will instead register temperatures and use thermal imaging to spot cars.

Adrian Fazekas at ISAC, Aachen had been working with camera detection for a long time. He used to identify fire or smoke in tunnels when he realised that the cameras also could detect traffic. With this in mind, he developed a system that could monitor the position of a moving vehicle from a film.

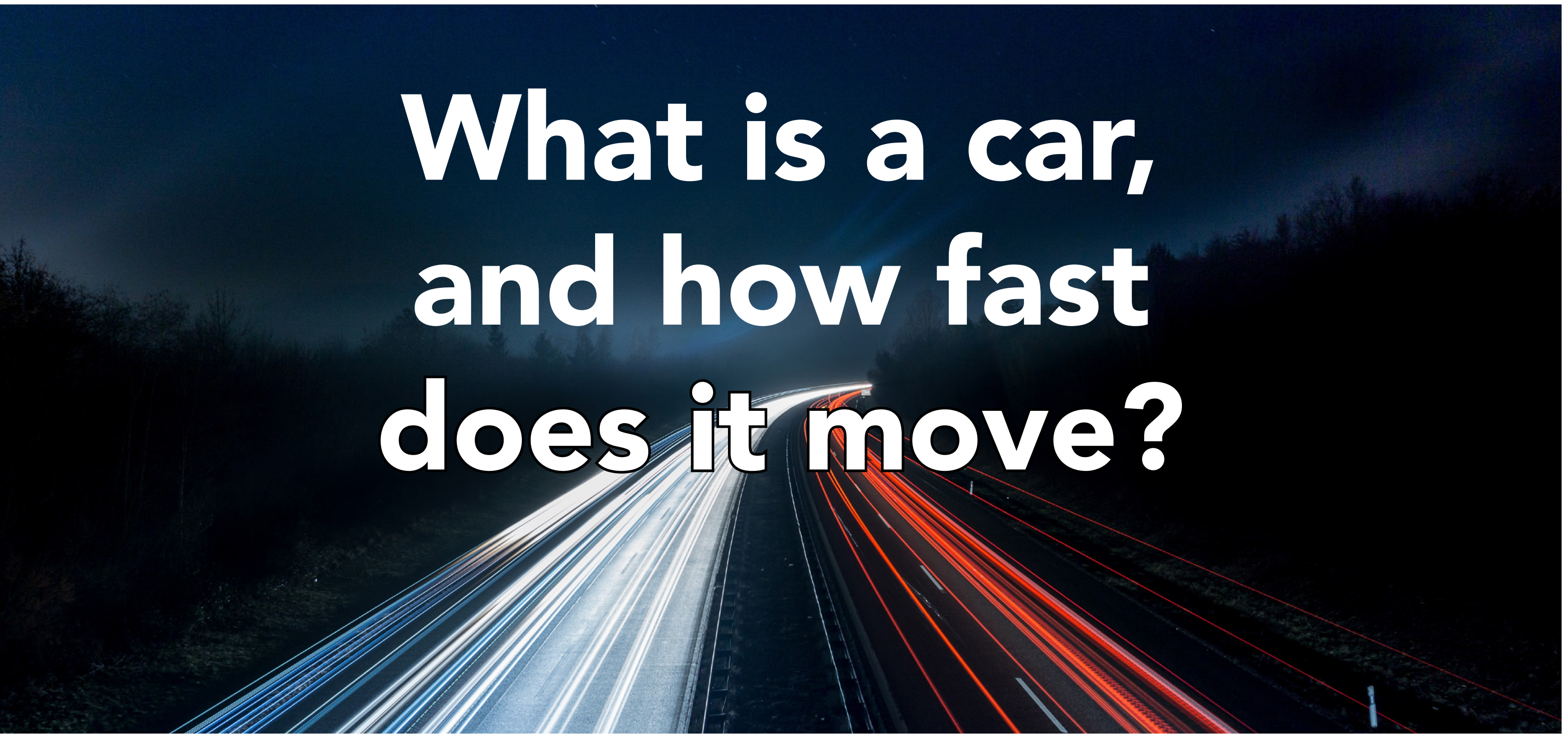
The only issue was that it worked in daylight, and not when it was dark. In dark surroundings, headlights from the car blur the images out and make it virtually impossible to see anything. Was there some way to capture an image without getting the light glare? There was.

Light has no temperature, but other things have. It would be possible to measure the temperatures of everything around with a thermal camera and translate this into a picture. This would mean no glare effects from lights, as well as the ability to see in total darkness without revealing any explicit details. As long as there is a temperature difference between the objects, that is.

This has proved to work well, according to Adrian's fellow scientist Moritz Berghaus. All cars in the early tests have been possible to spot, as there is likely always a temperature difference between car and road. In winter, the car is much warmer than the road and in summer the road is potentially much hotter.

There is of course a risk that somewhere in-between comes is a time when both cars and road share the same temperature. This is nothing yet encountered, and in case the car and road blur together it would be possible to calibrate the camera to more clearly emphasise minute temperature differences.

That said, there may still be problems with this type of camera. Heavy rain or fog could potentially make it difficult for to reach out and measure the correct things. However, even an ordinary camera will have problems coping with these situations. The future will tell if thermal cameras will be used everywhere, but it certainly looks warm to the MeBeSafe project.



What is a car, and how fast does it move?

It is easy for a human to see what is a car and what is not. For a computer, this has traditionally been very difficult. But emerging smart technologies make new ways of identification possible.

To select which car drivers to nudge for the light nudge, the cars must first be seen. A thermal camera can be used to get images of the actual site, but somehow the cars must be identified from the rest of the image. One cannot detect everything moving between two image stills, as it could be anything from grain flicker to a leaf blowing past. But computers have gotten a lot smarter in the last few years.

Moritz Berghaus from ISAC, Aachen, describes that the software has been taught to 'think', similar to the way an automated vehicle has. It all comes from intricate machine learning, in which the software is fed huge amounts of data and then learn by mass exposure and trial-and-error; as a human would.

After this, the complex algorithms will make it possible to find the contours of vehicles and not only detect what they are but also predict where they will be in a few seconds time. The approach works very well and only a few flaws exist. It is for example still difficult for the computer to differentiate between one large vehicle or two small ones close to each other at long distances.

The software does however not only need to identify which pixels are cars, but also measure their speed. To do this, the position and angle of the camera has to be known. A 3d-model of the actual road is then superimposed over the image from the camera and tilted so that it matches reality.

As the distances between various objects along the road are known in the 3d-model, they will also be for the real world images placed below. It is therefore possible to know exactly how far a vehicle has moved between two image stills, and thereby calculate the speed.

As several images are taken every second, it is possible to get a more or less continuous speed plot. So it is not only possible to see the cars and identify them digitally but also to note their speed. But then their speed has to be assessed to see whether the light nudge should be activated or not. And that is a totally different story.

Discerning when to actually nudge cars

Speeders in a certain highway exit will get nudged by lights turning on when their speed is too high. When the nudge is set and equipment put up, what is left? To decide when to activate the nudge, of course! And this is more complex than it may seem.

At first thought, it could seem wise to nudge every driver currently above the speed limit. Perhaps one should allow a few km/h extra, in case there is a misreading. It however appears that reality is not as simple as that. The speed limit changes in the middle of the actual exit curve, from 70 km/h to 50 km/h. A limit as sharp as that may work well in theory, but not in practice.

No vehicle can brake from 70 to 50 km/h in an instant. If these were the limits used for starting the nudge, the lights may suddenly be turned on when the driver passed the sign in 55, even though they are still slowing down.

It is not difficult to guess that this could lead to strange effects. There has to be some kind of smooth gradient in-between the two speeds, but how should this be made? This is something Moritz Berghaus at ISAC, Aachen is working with.

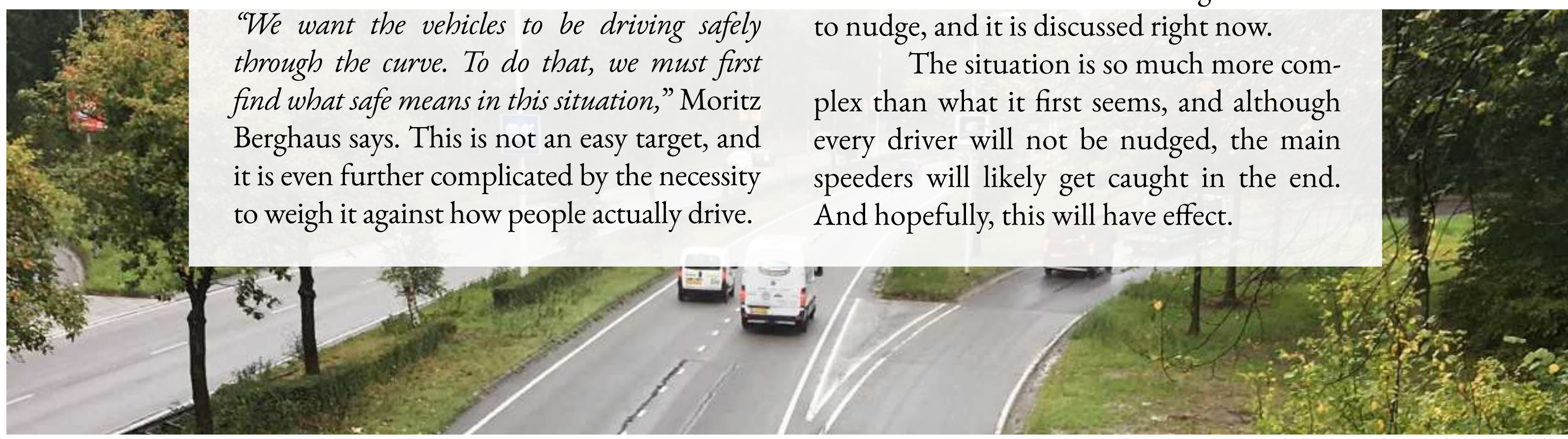
"We want the vehicles to be driving safely through the curve. To do that, we must first find what safe means in this situation," Moritz Berghaus says. This is not an easy target, and it is even further complicated by the necessity to weigh it against how people actually drive.

It may not be wise to nudge every single driver on a road, even if they are all speeding. One scientific reason behind is that it would be difficult to spot behavioural differences between those nudged and those not nudged over time. Fortunately, there is a lot of data on average speeds and speed distributions for the real curve that can to be used. This data could be analysed and used to find speed limits that will nudge a fair share of drivers. This may however lead to not nudging every driver who would actually need it.

Another issue that also makes it difficult to nudge everybody is the fact that cars often drive close to other cars. What should be done when several vehicles exit the curve close to each other at once? The nudge is made of lights in a row being lit up to form a pattern, and it is believed that at least 12 lamps must be visible to a driver for the nudge pattern to be apparent. If the cars are closer to each other than that, the rear car would not be nudged correctly.

If still trying to nudge both, it could mean that the patterns would interfere with each other. This is an issue that has to be taken into consideration when deciding which cars to nudge, and it is discussed right now.

The situation is so much more complex than what it first seems, and although every driver will not be nudged, the main speeders will likely get caught in the end. And hopefully, this will have effect.



Can cyclists be nudged haptically?

Cities all over the world are putting up physical obstacles to curb inappropriate cyclist speeds. It however seems like there is no reason to do so at all.

There are numerous ways to communicate using the haptic sense; by relying on what we can feel, such as pressure, touch and vibration. On a biking lane, the most common example is the complex of rumble stripes that are put up to give discomfort when crossing them at too high a speed. The reasoning behind may appear plausible, as vibrations are disliked by cyclists and increase with speed. But an experimental study done by Pontus Wallgren and Victor Bergh Alvergren from Chalmers suggests that the effect is very small.

Following two dedicated workshops, one in Gothenburg and one in the Hague, a large variety of potential haptic cyclist nudges were developed. Broadly, they could fit into three different categories; modified surface softness, modified surface roughness and tree-dimensional road modifications. Based on this input six different nudges were developed and tried on cyclists in Sweden, with the aim of decreasing speed before an intersection.

The test did not include the ordinary rumble stripes, as these have been found severely disliked by cyclists. Instead, the study used softer strips that actually gave way when biking over them, while still providing a clear feeling of running over something. The regular speed bump was replaced with a version in rubber, and a slope was made that was intended to slope up before an intersection – taking away speed – and to slope down after the intersection – giving the speed back. Additionally, soft ground, swampy ground and rugged ground – consisting of glued gravel – were taken into the tests.

The cyclists were subjected to the nudges and drove over them, but the effect was surprisingly low. The speed barely decreased at all, and most of the reduction occurred before the nudge; because the cyclists were not sure what it was the first time they encountered it. When cycling a second time, this effect would disappear totally.

The only nudge that actually had some effect was the slope, which would be very difficult to implement in real life indeed. To assure that the biking lane slopes up towards an intersection and down afterwards would require submerging the entire biking lane system a bit below the roads. Needless to say, this would give rise to numerous other issues.

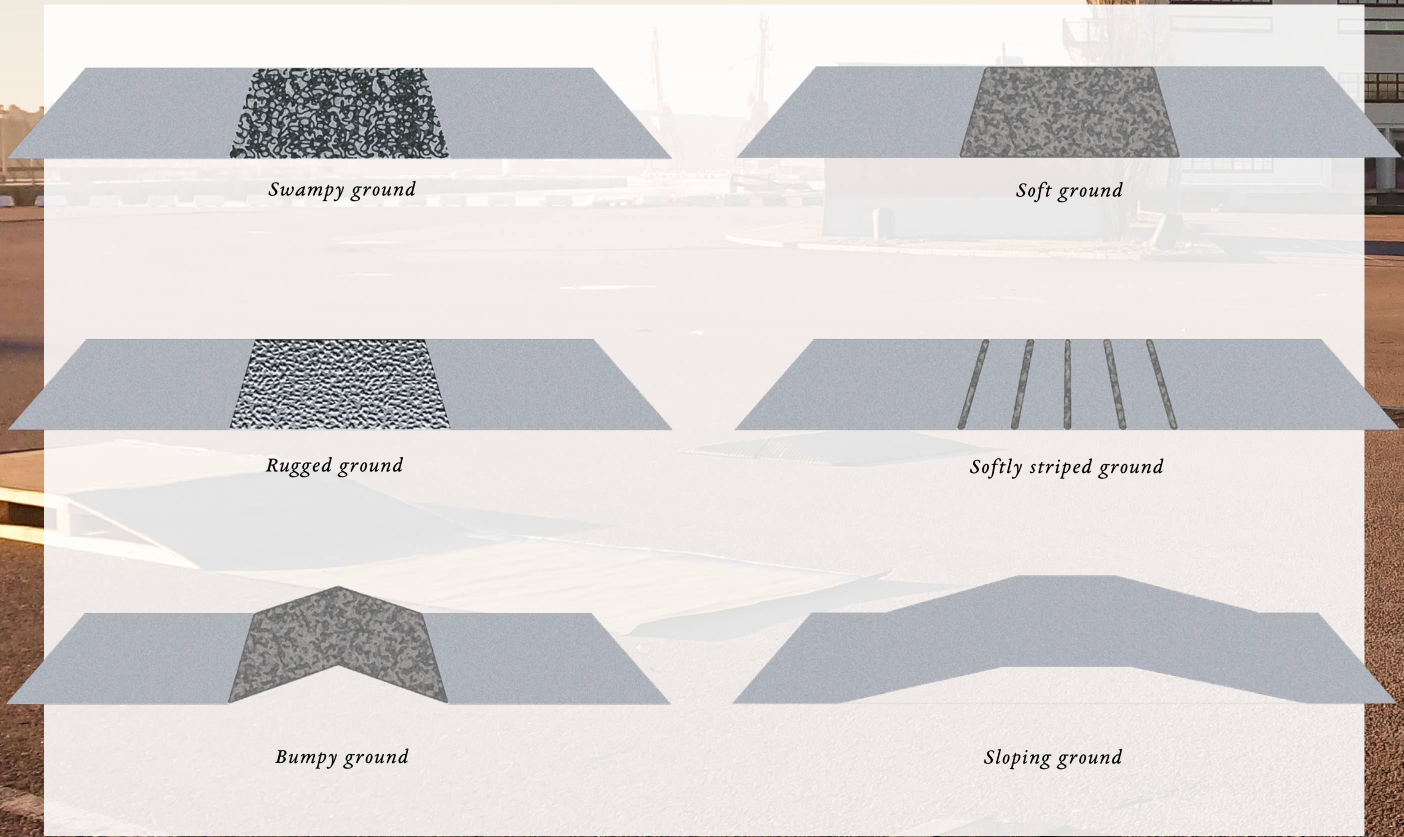
Low effect or very difficult to implement; none of these are actually the main problem. No, the main problem is that the cyclists strongly dislike the interventions. The more effect they have, the more disliked they are. A large share of cyclists would even do a reroute to avoid them; either out in the road or the pedestrian lane, or even choosing another way all together.

This is clearly a hard blow to those putting up haptic obstacles, believing it could affect cyclists positively.

Nevertheless, there is a strong light of hope in the seemingly dismal results. Chalmers recently did another study within MeBeSafe exploring how visual nudges could affect cyclists in real traffic.

The results from 93 tests persons were the very opposite. The visual nudges did not only find an almost universal approval, they also seemed to affect the cyclists to a very high degree. The results are not yet officially out, but they look very promising and will tested further in the field trials this autumn.

So all those cities putting up haptic obstacles in order to curb speeding may reach their goals much easier; if they just take a few steps backwards and replace the vibrating bumps with something that is only seen.



Novel ways to coach truck drivers

A new coaching system based on a mobile app was finally launched in Norway after an effortful development process. Several new techniques are being tested by four committed drivers, including peer-to-peer coaching and personal data integrity. And more improvements may be on the way.

Norway. A country where a truck driver may be just as likely to run into a mountaintop blizzard as a metropolis gridlock. Where roads may rise a thousand metres in front you or simply close down for half a day. This is the place where the MeBeSafe coaching system is up for trial.

The system revolves around a mobile application running on a phone mounted in the truck cab. It uses GPS for estimations of acceleration and braking, making it unnecessary to connect the phone to the truck itself.

However, it is not only based on automatically collected data. Truck drivers have the ability to contribute themselves as well. If something peculiar happens along the roads, they can press a large button on the screen to log that event for future discussions. At the moment, this feature may appear somewhat simple, but a future update could include a camera so that actual footage could be saved and more context provided to the logged events. This button was the only thing the researcher Anders af Wåhlberg initially wanted to show on-ride, but the developers saw it from another point-of-view.

Teri Lillington from Shell describes this as one of the major strengths in the MeBeSafe project; the ability to combine knowledge and perspectives from a large variety of stakeholders. The development team wanted to make the app attractive and interesting for the drivers as well, so that it would be appreciated and actually used.

So, a few animations and a speedometer were added to the on-ride screen, and the response from the drivers was really positive indeed. They have been found to appreciate both the look of the app as well as the functionality.

The main functionality of the app is of course to collect data to be used as a basis for the coaching sessions. Data that solely belongs to each individual driver. The company only gets aggregated data and the researchers only completely anonymised numbers. This is rather unusual, as companies are often in control of this information down to the most minute detail. Anders af Wåhlberg is very proud that MeBeSafe is taking another approach.

"I personally hate surveillance. Because that's what the companies usually do, assessing which driver is 'best' and which is 'worst'. How can we get the drivers' acceptance if that's what we're doing? And without acceptance, how can we get the systems to actually work?". Both Anders af Wåhlberg and Teri Lillington are very pleased with how well the collaboration with truck companies Litra and Gasnor works. The project could not have reached this far without their sincere support.

So in this project, nobody can force the drivers to show them the data. They are not even required to show it to a colleague when time has come for a coaching session, but they will hopefully do so due to positive peer pressure. Positive peer pressure is actually one of the theories forming the foundation of the peer-to-peer coaching method. Each driver will set a measurable and reachable goal together with a peer and will therefore feel that they at least have to try meeting it.

"How could we ever get the drivers' acceptance if we are monitoring them and then assessing who is 'best' and who is 'worst'?

"We actually use several methods from cognitive behavioural therapy for the coaching sessions", af Wåhlberg says, *"Most of them are very simple and can be taught to the drivers in just a short lecture. And this is necessary as there is no other way than to use peers. Professional coachers do not know the situation and we cannot decide that a few drivers are better than others. Now they are equal."*

The app launch ceremony in Norway. From left to right, A represenative for Shell, Bård Ivar Bru at Litra, the three drivers and researcher Anders af Wåhlberg.

The app will tell the drivers when a new coaching session is due, and suggest relevant topics they can read about beforehand and discuss. Ideally, the app should analyse the data from two peers who have formed a group and choose a time for the next coaching session based on their performance. Such calculations are highly complex, but the team's desire is to implement a large degree of complexity if a second version of the app becomes reality.

One of these issues is the fact that the extremely varying traffic environment in Norway demands extremely varying traffic behaviour, and this is something the app should take into consideration. What is deemed flawless behaviour on a motorway is lightyears away from good behaviour on a snowy gravel road in the middle of nowhere.

Researchers are hard at work to come up with solutions how this could actually be compared. Bram Bakker from Cygnify has developed a software to detect cars, pedestrians and other items from traffic videos, which could be used to measure what is going on outside the truck. It is however difficult to send the video to the software, when driving where no internet can be found.

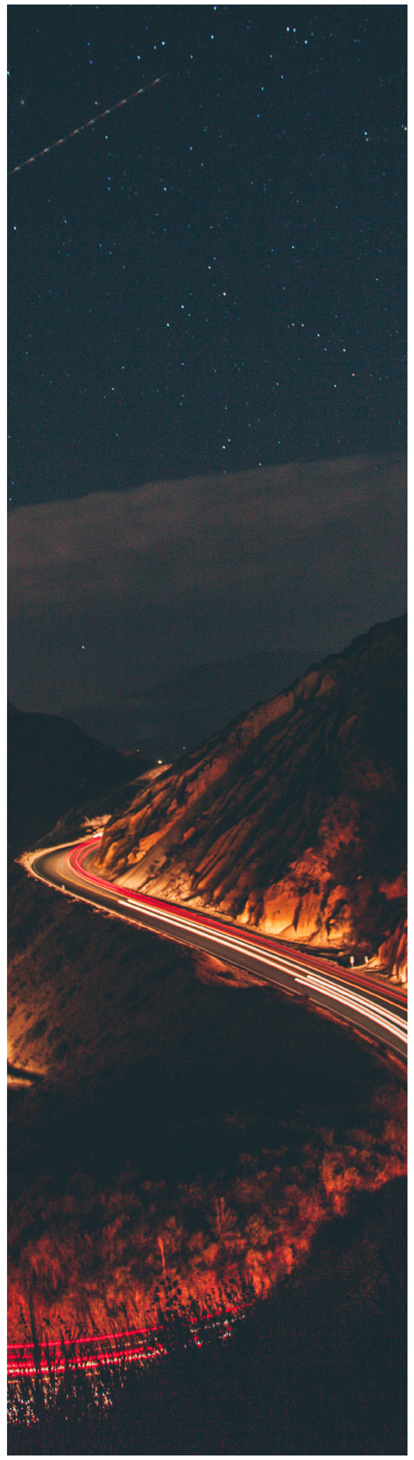
A second version of the app should also put a much higher focus on positive feedback. Generally, systems tend to put a much stronger emphasis on what is wrong and what is bad, not what is actually good. This is yet another complex area, demanding a very high degree of understanding the surrounding traffic environment to give a correct result.

At the moment, it is very uncertain if these plans will ever take the step out from the drawing board. More EU-funding is required to secure a second round of development, and the funds, development and trial testing must be done before summer if it is to be a part of MeBeSafe.

Anders af Wåhlberg is not very optimistic that this will be achieved but still speaks of the grandeur the scheme could achieve if it reaches its full potential. And as already the first version of the app is very appreciated and seems to help the drivers, one could only imagine how immensely far a second version could go.

When is a nudge satisfactory?

When an infrastructure nudge is set up and running, a completely new field opens up. Are the drivers nudged into safer behaviour? And what is actually safer behaviour?



When a nudge is active and measurements are being made, then comes the time to compare driver behaviour with and without the nudge. It may seem rather straightforward, but it is in fact not. Measuring difference in speed is one thing, measuring whether the speed was appropriate for the situation is a completely different story.

Moritz Berghaus at ISAC, RWTH Aachen will be doing a lot of the data analysis to see if the light nudge in has worked out or not. He will work out a number of parameters, including average velocities, speed distributions and lateral acceleration. But to make some kind sense of the data, it has to be translated into a single safety parameter. A parameter measuring the likelihood of a crash.

At this moment, Moritz and his colleagues are investigating which factors could be included in such a parameter. Except accelerations and configurations of the curve, many other external factors have to be taken into account as well.

Different weather conditions provide very different driving environments and can change numerous factors such as line-of-sight and modified friction for the wheels. Night and day time are not equal, neither are wet and dry roads. But even if the most important parameters are identified, the problem is to connect them to values of how dangerous they are, and which type of behaviour they require.

"It would be great to have lots of data on what happens before a crash," Moritz Berghaus proclaims. The problem is that accidents are rare, and MeBeSafe is striving to remove them. It would be a bittersweet paradox if we had to rely on crashes actually happening. *"So",* Berghaus says, *"it will be very interesting to see where we will end up with this in the end."*

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