D3.6 Enhanced toolbox of recommended data collection tools, monitoring methods and interventions including thresholds for the Safety Tolerance Zone.

Interview with Rachel Talbot

In this interview, where we reunite with Rachel Talbot, the last deliverable of WP3 is tackled. D3.6 can be considered as an update of several sections of D3.2. First the deliverable provides the final selection of driver performance objectives, the associated variables and how these relate to the three phases of the Safety Tolerance Zone (STZ). Secondly, the deliverable shines a light on the intervention strategies, when interventions are triggered and how driving style can be incorporated into STZ calculations. Furthermore, variables related to task complexity and coping capacity are detailed and it is explained how they will be measured for each mode. Lastly, the deliverable describes how the four identified mathematical models from D3.2 can be applied in the i-DREAMS risk analyses.

Hi Rachel, in this deliverable you provide several updates on D3.2. Which is the first update that you would like to share with us?

Rachel: *"The first one has to do with the performance objectives where the final selection that will be used in the field trials is described. As you know, the STZ distinguishes three phases: The <u>normal driving phase</u> where there is little to no crash risk, the <u>danger phase</u> where the crash risk is increased and the <u>avoidable accident phase</u> where a collision scenario develops, but there is still time for the driver to intervene and avoid the crash. The STZ is operationalised at the level of performance objectives (e.g. sharing the road with others), which are further translated into one or more of indicators (e.g. tailgating). Depending on where a driver is situated in the STZ, interventions are issued. And where you are in the STZ is based on the real-time assessment of the indicators under the aforementioned performance objective. So, determining which performance objectives and which underlying indicators we will work with, is crucial."*

Figure 1: The three phases in the STZ

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And which indicators do you work with?

Rachel: *"It is a mixture of indicators that we determined after reviewing literature and indicators that we could operationalize via the technology we work with. We also indicated the availability per mode. Going over that entire list, might be a bit too extensive, but if you are interested, you can check it in the deliverable itself."*

Then if I understand correctly, interventions are based on these indicators?

Rachel: *"Indeed! They are based on the indicators, but they work differently depended on the STZ phase that you are in. In the normal driving phase, no interventions are issued, in the danger phase warning messages are issued and in the avoidable accident phase these interventions become more intrusive. Each risk scenario (e.g. forward collision, speeding) has its own specific symbol and sound that changes in intrusiveness (size, sound level, intensity) according to the STZ phase you are in."*

And how exactly do you determine in which STZ phase a driver is to be situated?

Rachel: *"To determine that, it was important that we would define thresholds per phase. Some interventions have hard-coded thresholds, namely the following interventions: 'lane departure warnings', 'forward collision warnings', 'pedestrian collision warnings' and 'distraction warnings'. In those cases, it is easy: if you cross the line (e.g. if you depart from your lane without using the turn indicator), then a warning is issued, regardless of the context. On the other hand, we also have four context-based thresholds, where the context determines when an intervention is issued, namely in the case of 'headway warnings (tailgating)', 'illegal overtaking warnings', 'speeding warnings' and 'fatigue warnings'."*

How does that work then? How can the context influence when a warning is issued?

Rachel: *"Let's look at the example of the 'headway warnings'. The variable threshold is calculated by adding a penalty value to a base value, to issue the intervention sooner. In the case of 'headway warnings', the base threshold value is determined by the vehicle speed. The penalty value is based on indicators that estimate task complexity (e.g. bad weather conditions) and driver capacity (e.g. the driver is distracted). So, if you are driving at a certain speed and the system determines that it is raining and that you are distracted, the warning will be issued sooner than in the case of good weather and full attention. For each of the other three context-based thresholds, specific mechanisms are applied for the system to take into account the context."*

In the deliverable, I also read something about the role of someone's driving style and how that could play a part in the framework that controls the intervention triggering mechanism for different risk situations. Can you explain a bit how we should understand that?

Rachel: *"Yes, in my previous example I explained how the bad weather (= risk factor) could play a role in determining when a warning should be issued. How fatigued a driver is, is another example of such risk factor. Driving style may influence the effect of such a risk factor on the STZ. For example, driving at the speed limit (= driving style) may be associated with the 'normal driving phase' of the STZ in rear-end collision risk situations when the driver is not fatigued. However, that same driving style, namely driving at the speed limit, may be associated with the 'danger phase' when the driver is fatigued. Driving style thus has a moderation effect. Therefore, it is of great importance that we take driving style into account by including driving style factors as*

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independent variables in our mathematical models for data analysis."

How do you map a person's driving style factors?

Rachel: *"It will be difficult to determine someone's driving style in a simulator experiment, since that would require numerous hours of driving for each individual to clearly identify their respective driving style. So that will only be possible for the on-road trials. That is why we use the baseline phase in the on-road field trials. Remember, there we distinguish 4 phases throughout the 18 weeks of participation. The first four weeks are the baseline phase where no interventions are issued. In phase 2 (again 4 weeks) we start with the in-vehicle interventions. In phase 3 (also 4 weeks), we include post-trip feedback and in the last 6 weeks (phase 4) we add the gamification features. In the first 4 weeks we try to get an idea of how the driver operates without the interventions. That is where we try to determine the driving style. There we have the chance to see how a driver reacts to specific risk situations. Of course, there are also static elements that play a role here, such as personality characteristics and socio-demographic background. That type of information is collected via the entry-questionnaire that each participant completes at the beginning of their participation."*

OK, that brings me to the mathematical models that were already introduced in D3.2. How are they applied exactly in the i-DREAMS risk analyses?

Rachel: *"The mapping of the models to research questions depends on three dimensions for data analysis: (1) the purpose of data analysis, being prediction or explanatory analysis, (2) the time element of data analysis, being real-time or post-trip, and (3) the variable type of risk indicators, being discrete or continuous, as it may be necessary to test alternative definitions of risk in addition to the three-level STZ definition. The mathematical model to be used in i-DREAMS depends on a combination of these three dimensions. In the project, we mainly focused on the estimation of Generalized Linear Models (GLM) and Structural Equation Models (SEM) to model the impact of latent constructs such as coping capacity and task complexity on different indicators of risk (such as tailgating, speed)."*

Why is it necessary to test alternative indicators of risk in addition to the three-level STZ definition?

Rachel: *"The three-level STZ definition is useful for triggering and applying real-time interventions, but it does not present a complete picture of risk. Imagine a driver that has been driving for less than two hours. He engages in tailgating behaviour. According to the defined thresholds, the fatigue state of this driver falls within the 'normal phase' of the STZ, but the headway falls in the 'danger phase'. So, the current definition of risk is suitable for triggering the real-time headway warning, but it is not able to determine how likely it is that the driver will be involved in a risky event after all. This limitation is a direct consequence of not defining the overall state of the STZ for the driver. Other alternative definitions of risk are thus necessary to address this limitation. In the deliverable we described four other alternatives, so five in total. The definition of the STZ as an overall composite variable, thus a weighted sum of all STZ levels for different risk factors, is one of those alternatives which can be used to shed more light on the overall state of driving. The other alternatives are also explained in the deliverable."*

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That makes sense. I understand what you mean now. To conclude this interview … What do you see as the next step when it comes to the Safety Tolerance Zone?

Rachel: *"Following the conclusion of the field trials, two types of analyses will be conducted. The models that are described will be further utilised and developed during the analysis (WP6), for example to identify which factors most influence task complexity, coping capacity and how the STZ phases relate to this. The second will evaluate how effective the real-time and post trip interventions were on behaviour change (WP7) and whether this differs between the safety performance goals."*

Ok, a lot to look forward to then! Thank you, Rachel, for helping me understand all the complex work you did in deliverable D3.6.

Edith Donders

i-DREAMS DisCom manager

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Deliverable 3.6 is part of WP3:
Operational design
[Download the report here]

i-DREAMER in the spotlight

RACHEL TALBOT

Graduated as *psychologist in 2002 and PhD in Crash Causation in 2022.*

Employed at *Loughborough University since 2004.*

Passionate about *reading and going on walks with my family*.

Tasks in i-DREAMS: *Coordination of the development of the operational design including the methodology for the simulator and field trials; Coordinator of the Loughborough University contribution to i-DREAMS (rail and car modes)*