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POLICY BRIEF

What is the i-DREAMS "SAFETY TOLERANCE ZONE" and why do we need it?

CONTEXT

The road safety management system is evolving, and much of its evolution has been prompted by a consistent and growing technological change. However, other contributing factors to this evolution, such as the widening of the old driver-centric approach into a more modern and holistic idea of road safety, as well as the reframing of the driver's role into much more than just a mechanic action happening in a car, bus, tram, train or truck, have had an impact on the perspective we have of modern road safety and road safety technology.

The original concept of **the i-DREAMS 'Safety Tolerance Zone'** gives a fitting answer to how road safety technology should be redefined and pursued in a world where 'road safety' means an intertwine of aspects and elements, like roads, vehicles and people, education and training, policy, technology and acceptance, as well pre-crash, in-crash and post-crash actions and interventions, all in the broader and ambitious contexts of breaking the never-ending injury chain, raising awareness on climate change and eco-efficiency, and solving the challenges of road-stress and road rage.

iDREAMS

The project entitled 'Safety tolerance zone calculation and interventions for driver vehicle-environment interactions under challenging conditions' — 'i-DREAMS' aims to setup a framework for the definition, development, testing and validation of a context-aware 'Safety Tolerance Zone' for driving, within a smart Driver, Vehicle & Environment Assessment and Monitoring System (i-DREAMS). This framework should translate into new road safety interventions, improved driver well-being and transfer of control between human and vehicle, as well as a more eco-efficient driving style since safer driving implies an eco-friendlier behaviour

THE DRIVING TASK IS COMPLEX

A matter of altered perception

The driving task is a complex operation – a slight alteration upon driver's reflexes, judgement and overall perception of space, time and surrounding moving and stationary objects could result in a deadly combination.

Potential safety performance factors that could cause this alteration can be internally-induced, like anxiety, stress and illnesses (e.g. diabetes, sleep apnoea), or externally-induced, like impairment due to alcohol, substance abuse and use of medication, and distraction by the use of in-vehicle infotainment systems.

The driving task – the active intersection of vehicle, driver, weather, light, traffic, and roads – is a highly demanding operation that especially depends, amongst many elements, upon driver's reflexes, judgement and consideration of other road users. As **driving is a control task that is conducted in an unstable environment**, which is created by the driver's movement in relation to a defined track and moving and stationary objects, much of its concept can be theoretically explained by Control Theories.

Control theories assume that control actions made by drivers depend on one's perception of reality: this represents just another example of how humans selectively attend to environmental cues to make judgements regarding the state of the world, thus conducting self-assessments and often making inflated or erroneous estimates of their ability or performance. Simply put, it is an example of how **humans are prone to subjective evaluations that are not well-calibrated to objective measures**. While driving, this translates into drivers viewing themselves more optimistically, irrespective of actual performance, ability, or prospect . The result of such errors in calibration can be poor decisions or risky driving behaviour.

Testing limits

Human operators are inclined to change vehicle control if task difficulty is either too low (a situation typically experienced as boring) or too high (a situation typically experienced as threatening or dangerous).

As a simple example, in a rural roadway environment that involves few other road users, drivers may increase their speed to increase task load and reduce boredom.

Tasks adjustments made by the operator are not always based on conscious decisions, rather, they are often made in an automatic manner in response to increased affective arousal that accompanies the imbalance between task demand and coping capacity.

Within Control Theories, Task Capacity Interface[1] and Driver Calibration Framework[2], are considered particularly well-versed into exploring and further explaining the driving task. Both indeed highlight that a **safe performance when driving depends on the drivers' ability to recognize the relation between driving task demands and personal capabilities**, thus implying that well-calibrated drivers will recognize when task demands exceed individual capabilities, taking necessary measures to restore the balance, and poorly calibrated drivers may fail to take the necessary countermeasures, placing themselves at risk of crashing.

It is also interesting to notice that, even though a safe performance is essential when driving, **safety is not drivers' only motivation**. Indeed, drivers frequently compare the perceived risk with their individual's target or accepted level of risk, and then adjust their behaviour to reduce discrepancies between the two states[3]

WHAT IS THE I-DREAMS 'SAFETY TOLERANCE ZONE'?

The formal working definition for the 'Safety Tolerance Zone' (STZ) is: **"the time/distance available [for vehicle operators] to implement corrective actions safely [in the potential course towards a crash]"**.

To put it simply, the STZ translates into the real-world phenomenon of (technology-assisted) human operators self-regulating control over transport vehicles to avoid crashes. Of key importance to i-DREAMS is the point at which this self-regulated control can be considered as 'safe'. Though this safety concern is most prominent in situations where crash risk starts to develop or has further developed into a potentially imminent threat, one of the key-objectives of the i-DREAMS platform is to keep vehicle operators as much as possible in a state of 'normal driving', with the lowest possible risk of a crash scenario developing.

But, what does 'normal driving' mean?

The STZ is a window in the time-space domain: the window is opened from the moment that the vehicle engine is started, and the vehicle moves. For its continuity through space and time, the STZ is therefore considered a 'multi-phased' construct, consisting of three different phases:

[1] Fuller, R (2000) The task-capability interface model of the driving process, Recherche - Transports - Sécurité,Volume 66, 47-57. https://doi.org/10.1016/S0761-8980(00)90006-2.

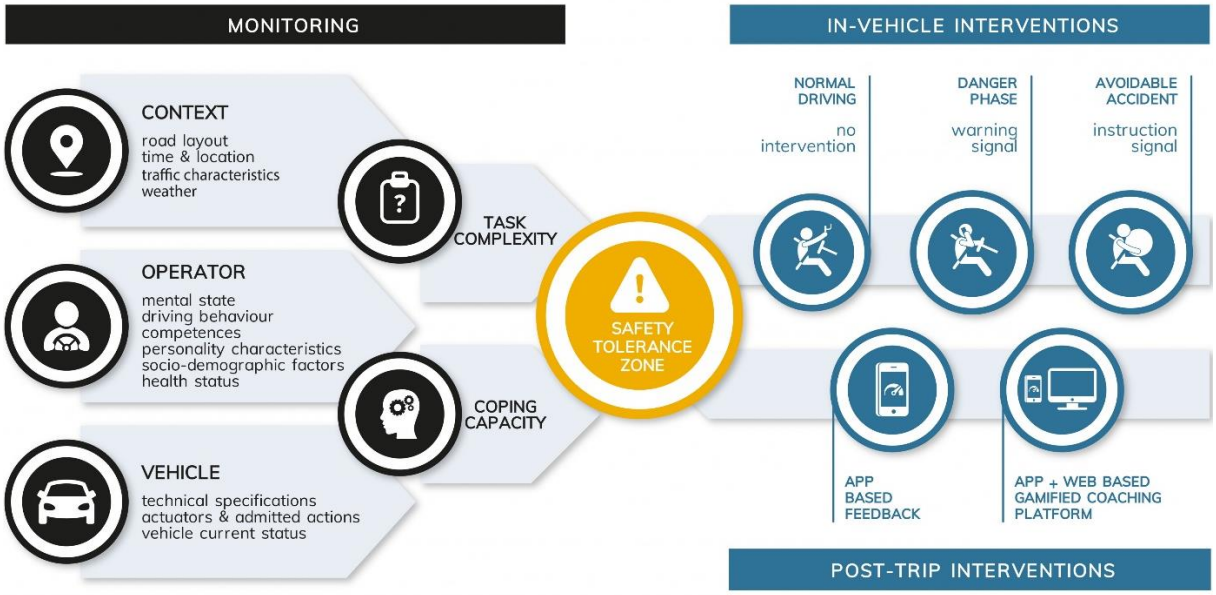
[2] Horrey W.J., Lesch M.F., Mitsopoulos-Rubens E., Lee, J.D. (2015). Calibration of skill and judgement in driving: Development of a conceptual framework and the implications for road safety. Accident Analysis and Prevention 76; 25-33.

[3] Wilde, G.J.S., (1998). Risk Homeostasis Theory: An Overview. British Medical Journal, vol. 4, no. 2, pp. 89

the **'Normal Driving'** phase, which is where the driver's coping capacity comfortably meets or exceeds the task demands; the **'Danger Phase'**, which is where the driver's coping capacity eventually deteriorates or the task complexity increases, thus leaving the driver operating on the edge of their capacity and increasing the risk of crashing; and the third phase, the **'Avoidable Crash Phase'**, which is where the task demands outweigh the coping capacity and a crash situation is unfolding but there is still time to take action to avoid the crash. In addition, the phases of the STZ determine the types of real-time intervention that are necessary: within the 'Normal Driving' phase there is no need for an intervention. Once the 'Danger Phase' is entered, however, a warning shall be given, but if the situation deteriorates further, then an instruction may be more effective.

Risk allostasis

The term 'Safety Tolerance Zone' has its roots in two different dimensions of reality. On one hand, the objectively observed state-of-the-world, of which the vehicle operator is an integral part; on the other, the vehicle operator's experience of the objective state-of-the-world (subjective reality) – where the drivers will make driving decisions based on their motivations and their own recognition and interpretation of risk. This is described as **risk allostasis**.



Conceptual Framework: *the i-DREAMS platform with the monitoring module (pillar I: Determination of safety tolerance zone via monitoring of task complexity and coping capacity) & interventions module (pillar II: Implementation of in-vehicle and post-trip interventions)*

WITH THE RIGHT APPROACH, VEHICLE AND DRIVER ROAD SAFETY CAN FOSTER SUSTAINABILITY AND EQUITY

Road injuries and deaths should not be accepted as inevitable: same it goes with climate change, energy depletion and mental and behavioural issues connected and amplified by driving. For this to happen, however, we have to highlight the interconnection between all of these modern challenges and global public health problems and tackle them at their source by working on a strategy that:

1. Improves road user behaviour in terms of safety, ecology and energy efficiency;
2. Enhances the safety of roads for all users;
3. Increases the use of new technology to reduce human error and balance the driving task performance;
4. Promotes equity amongst all road users;
5. Fosters road safety policy and programs through research of safety outcomes amongst different modes.

Vehicle safety and road safety technology as displayed in the i-DREAMS project encompass all five aspects.

The i-DREAMS system aims at improving drivers' well-being, as well as a more eco-efficient driving style. With these objectives, it fosters a holistic and modern road safety culture that takes into account how vehicle operators on cars, buses, trams, trains and trucks experience and react to objective reality, whether this is represented by the environment or other road users, thus fostering sustainability and equity.

By giving drivers the integrated technological support to reduce human error and balance the driving performance, **the i-DREAMS system allows the transfer of control between human and vehicle, but not the end of human agency within the driving task itself**. Indeed, the i-DREAMS' technology does not simply translate into a driverless, hyper-tech and non-human adaptation, but rather into a more conscious, present and safely performing number of drivers who are capable to enforce good practices on the road.

Tackling road safety, and in particular vehicle and driver road safety, by **monitoring the environmental context, as well as drivers and vehicles as a whole system, and not as isolated elements, is key to achieve an overall safer road traffic system**. By making sure that drivers perform safely and soundly along the roads, i-DREAMS addresses the safety of and reduces exposure to risk for all road users.

HOW TO FOSTER ROAD SAFETY TECHNOLOGY TO MAKE THE 'STZ' HAPPEN

The scale of the road safety challenge and the diversity of the effects of road traffic injuries and deaths underline the importance of exploring different ways of tackling these issues: excluding one mode or one users' segment are not possible solutions, nor it is trying to simplify the matter into a dichotomy of machine vs. men.

For this reason, **it is important to find a holistic solution that takes into account vehicles and drivers, too, giving them the chance to become more conscious, present and eco-efficient with the help of new-coming technology**. Vehicles like cars, buses, trams, trains and trucks will most definitely not disappear in the foreseen future, nor they should: in some cases, these vehicles are supporting vital assets of our modern societies, such as public transport and freight. **The way forward is then to promote a culture that allows all road users to safely share the road**.

This promotion, however, must be fostered through empirical examples that can prove the theoretical Safety Tolerance Zone in different locations and across different transport modes. In particular, the *i*-DREAMS platform will be tested in a simulator study and three stages of on-road trials in Belgium, Germany, Greece, Portugal and the United Kingdom on a total of 600 participants representing car drivers, bus drivers, truck drivers and train and tram drivers.

Giving priority to road safety technology to help with this harmonization reflects the high value that governments and the European Union place on the preservation of human life and the prevention of serious injury while not being tone-deaf in the face of the modern status of mobility. Drivers, in turn, have the essential role of developing positive approaches to safe road use, as road safety technologies are only as successful as the attitudes and behaviours of the road users implementing them.

National Authorities and EU authorities must foster an environment where vehicle and driver road safety are a vital element of the road safety strategy and the development of a safer road infrastructure: an environment where drivers are actively nudged towards safer behaviour. EU authorities should develop a comprehensive and coherent regulatory framework in support of new road safety and vehicle safety technologies, thus ensuring that these new technologies comply with traffic law in EU Members States.

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Project identity

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