

Meet LIV.

LIV - Learning Intelligent Vehicle
White paper 2018



veoneer



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LIV – the 2nd generation **Learning Intelligent Vehicle** is an artificial intelligence-equipped car that can understand and respond to context, developed by Veoneer.

LIV uses external and internal sensing combined with complex algorithmic AI to create a unified contextual picture of what is going on with the occupants, vehicle, and driving situation, and then act and communicate with drivers and passengers.

For instance, LIV can recognize when a driver appears preoccupied, and automatically increase the vehicle's following distance – and then explain its decision, thereby helping the driver and passengers learn about its functionality, just as it learns about them. When traveling with LIV, drivers won't feel the need to

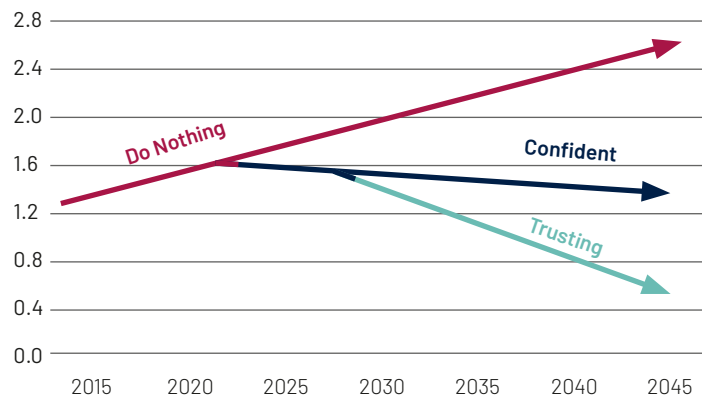
shut systems off entirely, but keep using them, thereby increasing both functional and perceived safety benefits. LIV is a research platform, allowing Veoneer to learn more about task delegation, shared control, and driver-vehicle collaboration. The LIV platform allows for a flexible approach to innovate ways to increase driver understanding of vehicle systems, and continually improve the system's understanding of its human co-travelers.

Veoneer believes this interaction will not only yield safer driving outcomes, but build the trust necessary to empower

autonomous vehicles to live up to their potential. The role of such collaboration – Human Machine Interaction, or "HMI" – cannot be understated as a central component of the autonomous driving revolution.

LIV represents the vision of Veoneer Research, and will inform the premium level of future products creating trust in mobility. LIV's learning and interaction with human beings will also impact state-of-the-art of safety development more broadly, ranging from AEB to driver monitoring and self-driving systems.

Global Traffic Fatalities (millions)



Driver Confidence

- Today's safety technology in all new vehicles
- Consumers willingness to buy and use
- Confidence in the vehicles' perception

Occupant Trust

- Driver co-pilot and shared control
- The driver considers the vehicle intelligent
- Eventually full trust in the vehicle to drive

The Human Factor in Autonomous Tech

As a vast percentage of the world's **1.4 million** vehicular deaths each year are attributed to human errors, it would be simple to assume that removing humans from the driving equation will reduce that number. It would also be wrong.

Human error is often used as an argument for vehicle automation: since people can't be trusted, the innovation mandate should be to automate driving entirely, and the problem will be solved.

The aviation industry's experience with adopting automation suggests this assumption is incomplete.

When manufacturers, carriers, and airport operators started automating tasks, they discovered that peoples' skills decreased when they were no longer required to perform those activities. This phenomenon, known as "skill degradation," was seen as a major impediment to rolling out new autonomous functions, as it reduced peoples' abilities to recognize and/or deliver the tasks that, quite literally, could be required to keep planes in the

air. It turned out that human performance plays a crucial role in adopting automation, and is a variable that can improve the overall success of safety systems (human error has long been understood as a symptom of deeper causes, and not a cause itself). Accordingly, both the Federal Aviation Administration and EASA encourage carriers to provide manual flying opportunities so pilots do not lose their skills, sometimes via simulators, and in some countries making it a requirement that they fly manually for a certain amount of hours to keep their skills level up.

The aviation industry has focused much of its resources toward cognitive task analyses intended to understand how people perform tasks, and therefrom build automation solutions for facilitated flying

and air traffic control that mitigates and/or leverages those skills.

Veoneer believes this insight holds true for ground travel safety as well, and with passenger cars in particular.

Automation will not be perfectly reliable in every condition, as inclement weather, dense traffic, and bad lane markings offer a nearly infinite number of challenges. Drivers will still need to be able to drive, when needed, making driver understanding of the system within which she or he is embedded, and the system's understanding of the driver, essential for achieving the vision of zero fatalities and zero serious injuries in road traffic.

LIV is a research platform intended to enable the study and design of such collaboration.





What Does the
Future of HMI Look Like?

WELCOME
Hi Katie!



Katie

“You don’t use your car like a smartphone, you literally put your physical safety in its hands, so **shared control** and **collaboration** are core to user adoption of new technology in cars.”

Ola Boström

VP Research & Patents, Veoneer

Currently, most consumer HMI vehicle systems present data to the driver in a very one-sided manner via performance indicators, status, and recognition of driver actions, like signaling. Driver engagement amounts to little more than the ability to switch the system on and off, and sometimes set parameters such as cruise control speed. It’s basically a monologue, not a dialogue within a shared context of experience.

Further, any knowledge improvement is up to the driver to acquire and then apply.

Changing this user experience dynamic will require significant innovation in system functionality, communication, and monitoring capabilities. The design of system logic and interfaces will be as important as those functional improvements, too, since the human-machine interface needs to provide a real-time understanding of what the other can and cannot do (and perceive). Shared control requires intelligence as well as learning.

The potential effects of qualities such as time pressure on driver performance and physiological activity cannot be overstated: it is vital for future HMI to

learn about individual drivers and specific tolerances, if only to avoid false positives and alerts that might cause them to disengage safety or comfort systems. Time and variability will be key, as the skills factor and time needed to act will differ not just between drivers, but among the hours and minutes of any given driver’s day. LIV will learn how to assess, anticipate, and respond to these factors.

For cooperation and shared control there will also need to be innovation in how the system and driver communicate about the appropriateness of actions in the given context. Cooperation cannot be achieved without communication about goals between driver and system, so it’s necessary to establish and maintain knowledge about what the driver and the systems knows, explicitly as well as implicitly. This means innovating not only when but how notifications are shared and going beyond warnings to encompass suggestions that will evolve as driver and machine learn about one another.

If the automated and human actors in a vehicle can make reasonable assumptions of the others’ performance, shared

control could be implemented using existing functions in different ways, such as adaptive cruise control, lane keep alerts, and semi-automated vehicle systems. The rise of capabilities in AI will be key for the machine side of that conversation, enabling the vehicle to learn about individual drivers’ limitations, skills, habits, and preferences.

In the future, vehicles will adjust to driver preferences in a natural way, rather than only providing the binary option of turning on or off, and take initiative as an active system rather than passively awaiting commands. For instance, more automation may be needed on a day when the driver has to focus on the children in the back seat, and less automation needed on a sunny day driving on gently winding roads.

LIV will allow Veoneer to explore how vehicles can make themselves understood, and facilitate the genuine two-way communication that will define the future of user trust and adoption of vehicular self-driving tech.



Innovating from Functionality to Trust

A major roadblock for adoption for currently available autonomous vehicle tech is lack of driver trust in the actual use of new technology. There's no reason to believe that tech will automatically get any better at addressing driver understanding and expectations just because cars get smarter.

We need to innovate trust.

Today, many drivers disable usage of intermittent vehicle automation such as lane keep assistance or adaptive cruise control, citing their belief that the functions are unreliable, provide feedback at the wrong times, or are simply annoying. System usage may also be sub-optimal as drivers are less aware of the systems' limitations, and some may not be aware that such assistance systems even exist in their cars.

It's unreasonable to expect that such hesitations will improve or disappear simply

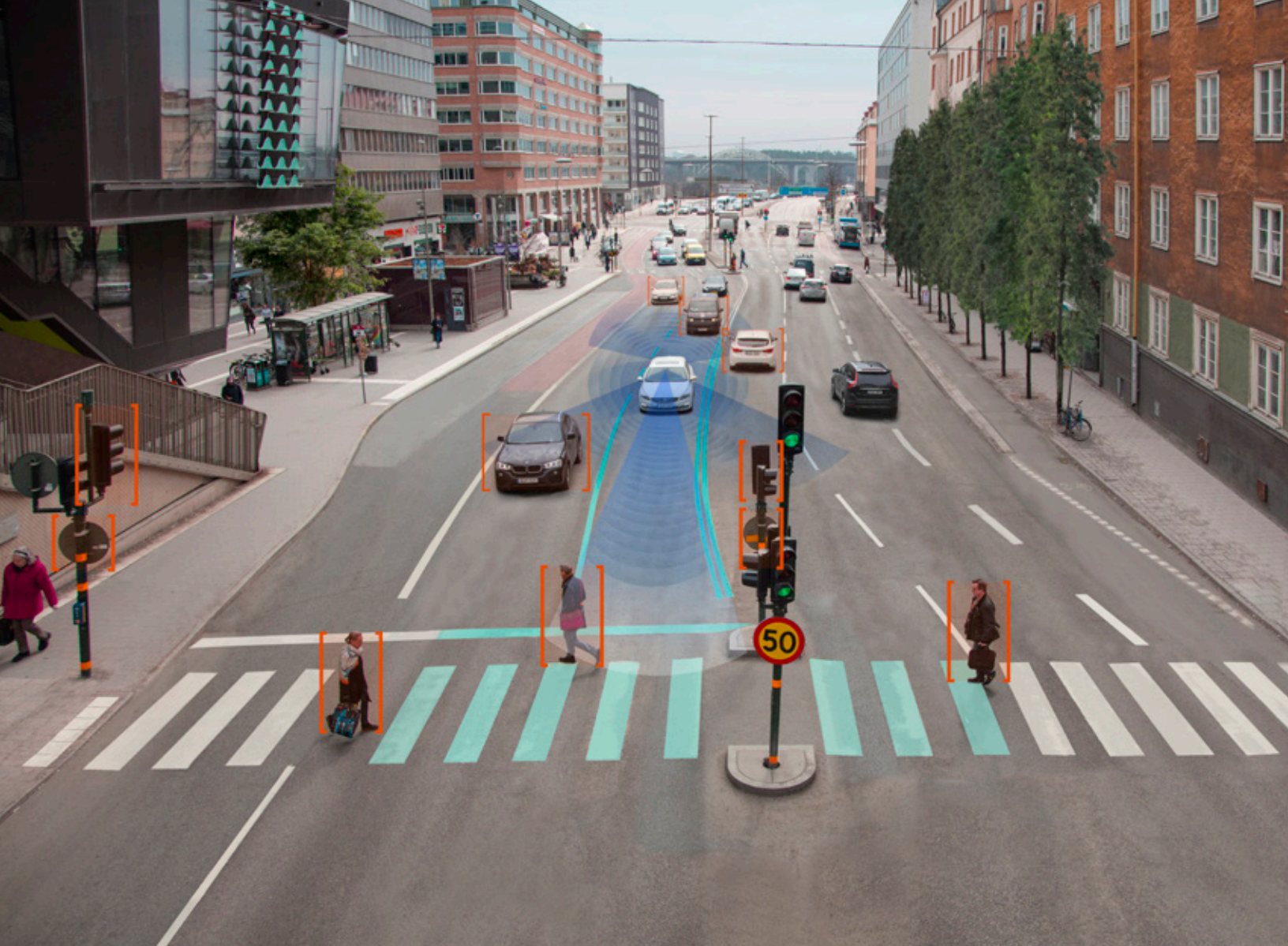
because technology gets smarter; in fact, resistance could increase. Some insightful research on driver experience with automation suggests a path forward, however: understanding between vehicle and driver is as important as technical functionality. LIV is designed to focus on both technology and user experience.

Unifying those two qualities to yield understanding and trust is easier said than done. In order to achieve the full safety benefits of vehicle automation, a driver needs to know when and what

system may be of use, which starts with enabling him or her to not just know the tech functionality, but feel when it might be useful. It's interesting to note that even the use of high beams is underutilized in areas where it would be helpful; even making them automatically dim toward oncoming traffic doesn't address the deeper user experience issues that challenge their use.

LIV tries to bridge such gaps in driver understanding and trust, based on the premise that trust is two-way. It's not





unreasonable to think that not only does a driver need to trust automation to perform its tasks, but that automation must trust the driver to perform his or her tasks. Otherwise, the system may be perceived as overriding the driver's intentions. This means that what happens inside the vehicle cabin is as important as how the car operates on the road.

For the driver to trust the vehicle, it needs to communicate its operational parameters, often in real-time. For instance, a vehicle needs to be clear about its capabilities to protect vulnerable road users and the occupants of the vehicle, but visual communication, haptics, and even sound are not enough to communicate it. Research suggests that drivers rely primarily on vehicle kinematics to perceive the capabilities of automated driving technology. The function of the

vehicle itself – positioning, accelerating, and braking – must operate in ways that rhyme with its visual and auditory communication with the driver. Self-driving vehicles will need to communicate through what they do, not just how they announce or indicate those functions.

For the vehicle to trust the driver, it needs to understand and answer to a driver's expectations. Its behavior needs to be understandable (especially when it comes to danger thresholds), but the system should also adapt in response to driver skills, state or habits.

Currently, there is no way for the driver to reliably notify the vehicle of her or his driving parameters (unfamiliar road, tired, distracted, alert, etc.), or for the vehicle to notify a driver that it can or has adjusted its functions due to changes in the driver's state. The physical indicators for

such human decisions are diverse and nuanced, and can include expressions and movement, requiring a more robust use of sensors in the interior of a vehicle cabin to assess them. LIV is intended to capture and use this data to understand driver intentions and performance, and thereby collaborate more effectively and reassuringly.

Veoneer is making the latest forays into a future of truly shared control, collaboration, and trust that will emanate from cross-disciplinary research into robotics, real-life safety and human factors.

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