

# ADDRESSING THE UNSPOKEN DESIGN CHALLENGE FOR AUTONOMOUS VEHICLES: MOTION SICKNESS

PAUL SCHOUTEN & TOMASO GROSSI



## WILL ROBOTAXIS MAKE US QUEASY?

One of the key promises of autonomous vehicles is that we will be able to be much more productive. Sitting back in “living rooms on wheels” we will be able to read books, watch movies and respond to emails. But what about motion sickness?



Motion sickness, also known as kinetosis, is experienced when there is a mismatch between how your body and brain perceive movement. For example, in a windowless vehicle your vestibular system - which governs balance - may sense that you are moving, but your eyes tell the brain that everything is still. This mismatch in movement perception can lead to symptoms such as nausea and dizziness.

Drivers rarely experience motion sickness, because they know what’s coming and can anticipate the motion by adjusting neck, shoulders, hips, and more. But what about when everyone is a passenger, maybe facing backwards and with limited visibility of the vehicle’s motion? Surveys show that, in an autonomous vehicle, over 30% of people would perform tasks that increase the likelihood and severity of motion sickness such as reading, watching movies, playing games or working.

Does this mean the vision of greater freedom and productivity is over before even hitting the road? At TomTom, our mission is to power a safe and comfortable driving experience, so we took it upon ourselves to find ways to mitigate this side effect of autonomous driving.

## TOMTOM MOTIONQ - DRIVING COMFORT IN AUTONOMOUS DRIVING

One of the great design challenges of autonomous vehicles is to let passengers feel safe and comfortable. Safety means letting passengers know that the vehicle is aware of its surroundings and that it can safely handle all driving scenarios. Comfort means a smooth driving style coupled with motion anticipation. Motion anticipation is about enabling passengers to anticipate the movements of the vehicle by adjusting and stabilizing the body to avoid or mitigate motion sickness. But what is the best way to help passengers anticipate motion?

The Rinspeed Snap proved to be the perfect vehicle to experiment and test different concepts. An innovative autonomous robotaxi pod designed as a configurable, shared living room on wheels, the Rinspeed Snap uses TomTom HD Maps to power its autonomous driving system, enabling a safe and comfortable experience. When envisioning the role of navigation in a robotaxi, we reached the conclusion that one of its main functions is to inform passengers of the route of the vehicle and of its planned motion. That’s when we

realized that robotaxi passengers need advanced visual cues to help them anticipate the vehicle’s motion and “stabilize” their body accordingly. And that’s how we started developing the concept for TomTom MotionQ.

TomTom MotionQ is a set of visual cues that enable passengers to anticipate an autonomous vehicle’s motion, leading to a safer, more comfortable experience. TomTom MotionQ provides intuitive overlays on the central display that communicate the vehicle’s intended motion. This includes the vehicle’s path, turns and acceleration, as well as road elements of the TomTom HD Map such as road borders, lanes, markings, centerlines, traffic signs and traffic lights. When designing TomTom MotionQ we applied a ‘looming’ effect, meaning the intensity of the motion is communicated through the change of intensity of the shapes. In addition, gradual anticipation allows for more comfortable motion anticipation, allowing passengers to gradually ‘sense’ the planned motion. Tweaking the combination of these elements for front-facing and rear-facing passengers, as seen in the Rinspeed Snap, enables a more comfortable experience for autonomous vehicle passengers.

Front-facing passengers are presented with a view of the world as seen from the robotaxi's front-facing camera, augmented with overlays that show the vehicle's path. Changes in color and intensity reflect changes in speed as well as potholes and speedbumps, and traffic signs and traffic lights are clearly labeled.

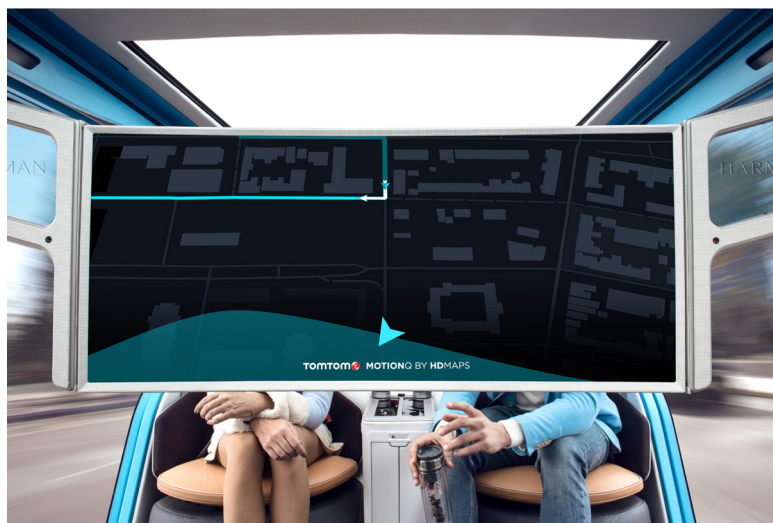
Rear-facing passengers are presented with a minimalistic and optimized map view – to avoid the contrast of the front-facing camera view and opposite direction of travel – coupled with a visual cue at the bottom of the screen that helps the passengers anticipate and adjust to the vehicle's motion. Both the map and the visual cue are mirrored to reflect the fact that rear-facing passengers feel motion in the opposite way. This specific visual cue is unobtrusive, allowing it to be overlaid on various content such as movies, news, etc. This motion cue can also be used for front-facing passengers as a less obtrusive alternative to the full-screen overlays. This allows passengers to view other content on the screen, while still being able to see clear cues as to what motion is coming next.

Another important consideration for shared autonomous vehicles is that passengers must be able to always monitor and explore their route. Passengers need to be able to check their ETA, see where the next passenger will be picked up, and explore points of interests (POIs) along their route. The TomTom Route Genius does just that, informing passengers of all the aspects of their journey, from accurate ETA information, to relevant POIs along the route, from next pick-up points to detailed traffic information. While the MotionQ allows passengers to anticipate the vehicle's motion on a micro level, leveraging HD Map data, the Route Genius allows passengers to anticipate and monitor the vehicle's motion on a macro level, with more high-level information on the journey.

## TOMTOM POWERS SAFETY AND COMFORT FOR AUTONOMOUS DRIVING

TomTom is on a mission to make autonomous driving a reality, by building highly accurate, highly scalable and highly updated HD Maps to enable a safer and more comfortable experience for automated driving systems.

With MotionQ, TomTom leverages its autonomous driving products - such as HD Maps - to design concepts that will make robotaxis more comfortable and enable passengers to be more productive and enjoy the ride without side effects.



**Paul Schouten**  
UX Designer

**Tomaso Grossi**  
Sr. Product Marketer