



Motional

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We move you.

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Bi-Annual Report for MassDOT & City of Boston

1st Half 2022

Background

Motional is committed to designing for people: for families that need to get their children to school safely; for elderly passengers who need continued access to mobility; and for urbanites who, more than ever, have a choice in how they get around cities. We know that self-driving vehicles have the potential to bring vast benefits to humanity: increased mobility, fewer traffic-related deaths, and a greener planet. But the only way to fulfill these promises of tomorrow is to build trust in the technology today. We believe that when we demonstrate openness and collaboration, trust follows.

Our team's expertise in autonomous driving can be traced from our R&D roots at MIT and Carnegie Mellon University, where we showcased our autonomous technology in the DARPA Grand Challenge and DARPA Urban Challenge, to our present-day commercial

operation in Las Vegas, which has safely provided more than 100,000 self-driving rides to members of the public. We are proud to report that our attention to safety has extended into our real-world operations. We have driven over 2,000,000 miles in complex city environments worldwide while maintaining a record of zero at-fault incidents.

Today, our global team—spanning the U.S. and Asia—is dedicated to delivering safe and reliable production-ready SAE Level 4 robotaxis that will make roads safer and improve mobility worldwide. As our global headquarters, Boston is a vital part of our research, development, and testing ecosystem. We're continuing to invest in our Boston operations and are currently hiring for over 100 new positions.

In September 2021 we made an important reveal in collaboration with Hyundai, the design of our all-electric robotaxi based on the Hyundai IONIQ 5. The IONIQ 5 robotaxi has all the IONIQ 5's consumer-centric features that wowed the industry when unveiled in February 2021 - such as the neo-retro design, parametric pixel lights, auto flush door handles, low-profile interior, vehicle-to-load charging system, fast-charging capabilities, and 18.8 cubic feet of storage space - plus Motional's industry-leading AV technology package baked right into the design.

For the past decade, Motional's international R&D team has tapped into its Boston corporate headquarters, operations hub, and state of the art closed-course testing facility. In 2021, Motional committed to continuing to grow its footprint in its Boston hometown. To support the 2023 deployment of Motional's Level 4 robotaxis, we made a multimillion dollar investment to expand our Seaport operations facility at Black Falcon, conduct extensive hiring, and increase R&D testing.

The expansion of the operations facility will double the usable space and triple the available occupancy for Motional's talented teams to develop safe and smart Level 4 systems. With the added space, Motional plans to grow our local team by adding more than 100 new Boston-based positions in engineering, product, and IT functions. Along with the expansion, Motional plans on increasing testing on Boston public roads with the all-electric IONIQ 5 robotaxi in preparation of Motional's fully driverless public robotaxi service launching in Las Vegas in 2023.

Testing activity

Our testing efforts continue to focus on the Hyundai IONIQ 5 platform, which includes more advanced hardware and technical capabilities compared to previous generations. We are working on transitioning our testing to our IONIQ 5 test car to our IONIQ 5 prototype vehicle. The prototype vehicle incorporates passenger experience features for ride hailing. Including passenger display that displays ride information, remote control assist button to help passengers connect with a remote representative, and external displays and lights that help riders identify their vehicle.

Operational Design Domain (ODD)

Our vehicles are designed to operate in low-speed, urban environments in various conditions. We validate vehicle performance using simulation and bench tests, then in a closed-course setting before operating on public roads. To date, we have experience testing on public streets with a variety of road actors, including heavy vehicle traffic, emergency vehicles, construction, cyclists, and pedestrians. Additionally, we have operated our AVs safely in daytime and nighttime, and windy, rainy, and snowy conditions in closed-course and public road environments.

Amount of testing

Our testing occurs primarily during regular business hours (Monday through Friday, 9AM-5PM). This includes specialized closed-course testing at our test track in Suffolk Downs and on-road data collection and autonomous driving in the Seaport.

Takeover procedure

Motional's vehicle operators can take over and manually control the vehicle in any situation in which they feel uncomfortable or unsafe. Planned takeovers are also done when finishing a mission or approaching situations that are not within the outlined ODD. We are also refreshing our fault injection training with all vehicle operators where intentional system errors are introduced to make sure our operators takeover in the proper fashion before returning to public roads.

During the first quarter, our vehicle operators took over manual control of our AVs in the following situations:

- When emergency vehicles were in active operation (e.g., sirens and lights activated) on the roadway;
- When law enforcement officers were manually directing traffic in intersections through which our AVs were traveling;
- When construction vehicles were obstructing our lane of travel;
- When oncoming vehicles or bicycles violated lane boundaries;
- When weather conditions deteriorated rapidly; and,
- When other vehicles were exhibiting erratic behavior near our AVs.

A vehicle operator's decision to take over manual control in a given situation does not necessarily indicate that continued autonomous operation in those situations would be unsafe. Because we instruct our vehicle operators to err on the side of caution,

we expect that takeovers will occur in many cases in which the AV would have handled the situation without incident.

Description of ADS system failures

We did not experience any unanticipated failures or disruptions while driving in autonomous mode. As we explain above in greater detail, in specific traffic scenarios, our vehicle operators take over manual control because of known limitations of the current state of AV software.

Goals for future testing

We continue to test our autonomous capabilities through closed-course track tests before transitioning to public road driving. Our IONIQ 5 vehicles are currently operating autonomously on public roads.

We are supporting internal autonomous rides around the Seaport for employees to experience the product they created and provide feedback.

We are supporting the enhancement of our sensors by collecting data while driving manually in rainy conditions. Collection of this data will help improve our autonomous performance of our LiDars, radars and cameras in rainy weather.

We are also using our IONIQ 5 robotaxis and our new simulation and virtual reality space to gather user experience feedback from the public. Motional's Product team will continue to get feedback from a diverse background regarding the capabilities they would like to see

while riding in an autonomous vehicle in different scenarios.

We plan to host demonstrations for stakeholders from the city of Boston and MassDOT to learn more about our company and our technology.

Insights

Following last year's announcement of a Motional-Uber partnership in May, Motional and Uber launched autonomous deliveries for Uber Eats' customers in Santa Monica, California. Motional's all-electric IONIQ 5 vehicles, operating autonomously, are now conducting end-to-end food deliveries. The partnership signals important firsts for both companies: the first on-road autonomous vehicle ('AV') pilot on the Uber Eats network and Motional's entry into the autonomous delivery market. Motional and Uber see an opportunity for AVs to benefit the on-demand delivery space by providing safe, cost-efficient, and reliable deliveries - and our products and testing teams in Boston are helping to support the software that is run on the Uber Eats vehicles every day.

Participating merchants will receive a notification when the AV arrives, meet the vehicle at the designated pick-up location, and place the order in a specially-designed compartment in the backseat. Upon arrival at the drop-off location, the customer will receive an alert, securely unlock the vehicle door via the UberEats app, and collect their order in the backseat.

An important design factor for Motional was to ensure that the vehicles retained a dual use possibility - specifically, they could be used for passenger service or for goods delivery. The team had to overcome a variety of challenges like ensuring that the design provided ample room for passenger luggage or shopping bags, while still being able to transport food and goods spill-free.

Motional's product and engineering teams faced a variety of additional design challenges before making this partnership operational. For one, the design needed to accommodate for the needs and desires of both the end-customer and the merchant, rather than accommodating only for the passenger as in Motional's passenger service. Also, the compartment needed to accommodate a wide range of food packaging shapes, sizes and temperatures. Finally, the design had to compensate for human behavior - merchants don't always load orders as expected and customers may be distracted on their phones as they retrieve their items.

This initial partnership will allow Motional and Uber to study the integration of their technologies, consumer demand, the user interactions with the AV, and additional autonomy features needed to enable autonomous deliveries. These factors are critical for a seamless customer experience and will also help inform broader applications of Motional's AV fleet.

Feedback for municipal and state transportation engineers, planners, and policymakers

At Motional, we've spoken at length about the safety of our technology and its potential for communities. But we know that achieving safe streets requires a broader, more holistic perspective that considers the needs of everyone, no matter how they get around. These issues demand more dialogue, and limiting the conversation to AVs would also be limiting the opportunity to make an impact. To that end, we're launching *Motional for Safe Streets*, a new initiative where we'll use our resources to create positive change across a wide variety of causes impacting road safety in urban areas.

Through *Motional for Safe Streets*, we'll use our voice as a leader in advanced mobility to raise awareness of the safety challenges faced by all who share the roadways. We'll help address the challenges at the legislative and community levels by supporting public and private sector organizations and efforts that are part of the movement.

We've launched this initiative in California where we are supporting a variety of bike safety legislation and we are partnering with organizations like CicLAvia and Streets are for Everyone (SAFE) that are already driving change. We are beginning to launch our Massachusetts efforts and look forward to

working with MassDOT and the City on these important issues.

At Motional, "Safety as our Bedrock" is one of our core company values. This means we embed safety throughout our product ideation, development, and deployment activities with precision and rigor. And, where industry rules and standards don't exist, we lead the way. *Motional for Safe Streets* extends this pledge beyond just our own passengers and vehicles and adds a new dimension through our focus on overarching road safety.