TUSIMPLE SAFETY REPORT

VERSION 2.0

CONTENTS

CHAPTER 1
INTRODUCTION

OUR MISSION

- Increase Safety
- Decrease Transportation Costs
- Reduce Carbon Emissions

ABOUT US

TuSimple is an autonomous driving technology company headquartered in San Diego, and operates a fleet of autonomous trucks out of Tucson, Arizona and Dallas, Texas. Founded in 2015, TuSimple is developing a commercial-ready Level 4 (SAE) fully autonomous driving solution for long-haul heavy-duty trucks. For more information, please visit www.tusimple.com, and follow us on Twitter, YouTube, and LinkedIn. To learn more about AV testing around the United States and TuSimple please check out AV TEST Initiative.

TuSimple aims to transform the $800 billion U.S. trucking industry by enhancing safety, increasing efficiency, and significantly reducing operating costs. Today, TuSimple operates a fleet of 50 autonomous trucks on the TuSimple Autonomous Freight Network.

ABOUT US

Company History

SEP 2015	Founded with headquarters in San Diego, CA.
SEP 2016	Awarded ten world records for autonomous driving on the Karlsruhe Institute of Technology and Toyota Technological Institute (KITTI) and Cityscapes public datasets.
AUG 2017	Opened testing and development facility in Tucson, AZ and began testing the TuSimple Autonomous Driving System (TADS) between Tucson, AZ and Phoenix, AZ.
FEB 2018	Expanded to a new 50,000 sq ft production facility in Tucson, AZ to house our truck fleet.
AUG 2018	Began hub-to-hub autonomous hauling for customers in Tucson, AZ.
DEC 2019	University of California San Diego study found TuSimple trucks at least 10% more fuel efficient than traditional trucks.
JUL 2020	Strategically partnered with Navistar and ZF to co-develop SAE Level 4 autonomous semi-trucks targeted for production by 2024.
JUL 2020	Launched the Autonomous Freight Network, an ecosystem consisting of autonomous trucks, digital mapped routes, strategically placed terminals, and TuSimple Connect, a cloud-based autonomous operations oversight system.
SEP 2020	Entered into a global partnership with TRATON GROUP to develop program to operate the first SAE level 4 autonomous hub-to-hub route between Södertälje to Jönköping in Sweden using Scania trucks.
NOV 2020	Designed initial wear studies with strategic partner, The Goodyear Tire & Rubber Company, to understand how autonomous trucks and tires can help predict better maintenance, understand tire longevity, and reduce the fleet carbon impact.

SAFETY AND WORKFORCE ISSUES FACING THE TRUCKING INDUSTRY

TuSimple's autonomous driving technology can help improve safety and address the driver shortage.

The average age of truck drivers in North America is **46-50** years.

The truck driver shortage is projected to reach **105,000** by 2023; **160,000** by 2028.

During the third quarter of 2020 there was a **74%** driver turnover rate at small carriers and **92%** turnover rate at large carriers.

On average, there have been **3,743** fatal crashes and over 80,000 injury crashes per year involving large trucks since 2010.

More than **50,000** drivers were disqualified by the Drug and Alcohol Clearinghouse in 2020.

On average, there have been over **290,000** property damage only crashes per year involving large trucks since 2010.

In 2020, **100,000** fewer commercial driver's licenses (CDLs) were issued than prior years due to CDL school and license branch closures.

At least **1** driver-related factor was recorded for all fatal crashes involving large trucks in 2018.

LANDSCAPE FOR AUTONOMOUS TRUCKS

Long-haul trucking, generally recognized as routes requiring goods to be delivered further than 250 miles from the truck's origin, is an essential and significant portion of the U.S. economy and is facing a number of safety and economic issues.

TuSimple believes that our autonomous driving solution can help the industry mitigate or eliminate some of the most pressing issues in trucking, such as driver retention and shortage, vehicle parking, traffic congestion and safety, while maintaining the cost and convenience advantages the trucking industry relies on to be America's preferred freight movement method.

We are proud to spearhead efforts to understand how autonomy will be a net-add to our communities. Not only have we concluded that autonomous trucks can benefit drivers, but we have also invested resources to prepare drivers for a career in this budding industry. We have recently partnered with Pima Community College[1] to create an education program that equips truck drivers with the skills needed to be successful in the autonomous trucking industry. Our students will be prepared for new jobs such as training the autonomous system as test drivers, operating the vehicle in situations where autonomous driving is not suitable and to remotely monitor the system from a command center. We are proud that eight students have completed the course so far and are on track to be certified for employment.

As this past year has shown us the vulnerabilities across our supply chains, we are optimistic about the opportunity for autonomous trucking to help our food system become more robust and sustainable. About 30-40%[2] of our food supply goes to waste with spoilage being one of the top reasons[3]. Additionally, food represents about 26% of global greenhouse (GGH) emissions[4]. It is startling to see how food waste unnecessarily contributes to global warming. By providing increased freight capacity and reduced transportation times, we are excited about our role in helping America tackle its climate and food waste challenges.

GROWING FREIGHT DEMAND AND INCREASING COSTS[5]

- Nearly 72.5% of domestic freight tonnage in the U.S. was moved by truck in 2019.
- The annual shipping tonnage in America requires over 3.91 million Class 8 trucks and over 3.6 million truck drivers in 2019.
- Freight volumes are projected to increase 35.6% from 2018 to 2029.[6]
- Total tonnage may reach ~21.7 billion tons by 2029.
- The mean compensation for truck drivers in 2019 grew by 11.5% to $58,000 compared to 2017 levels.[7]

1. https://www.pima.edu/news/press-releases/2019/201906-tu-simple.html
2. https://www.usda.gov/foodwaste/faqs#:~:text=In%20the%20United%20States%2C%20food,percent%20of%20the%20food%20supply.
3. https://www.rts.com/resources/guides/food-waste-america/#:~:text=The%20facts%3A%20How%20much%20food%20is%20wasted%20in%20America&text=That's%2080%20billion%20pounds%20of,up%20space%20inside%20US%20landfills.
4. https://ourworldindata.org/food-ghg-emissions
5. https://www.trucking.org/economics-and-industry-data#:~:text=11.84%20billion%20tons%20of%20freight,of%20total%20domestic%20tonnage%20shipped.
6. https://www.refrigeratedtransporter.com/carriers/article/21721717/freight-forecast-projects-continued-growth-for-trucking
7. https://www.dcvelocity.com/articles/46119-study-truck-driver-pay-is-on-the-rise#:~:text=ATA%20says%20its%20study%20shows,solo%20van%20drivers%2C%20ATA%20said.

OUR AUTONOMOUS SYSTEM

HD MAP

PLANNING

LOCALIZATION

PERCEPTION

CONTROL

PREDICTION

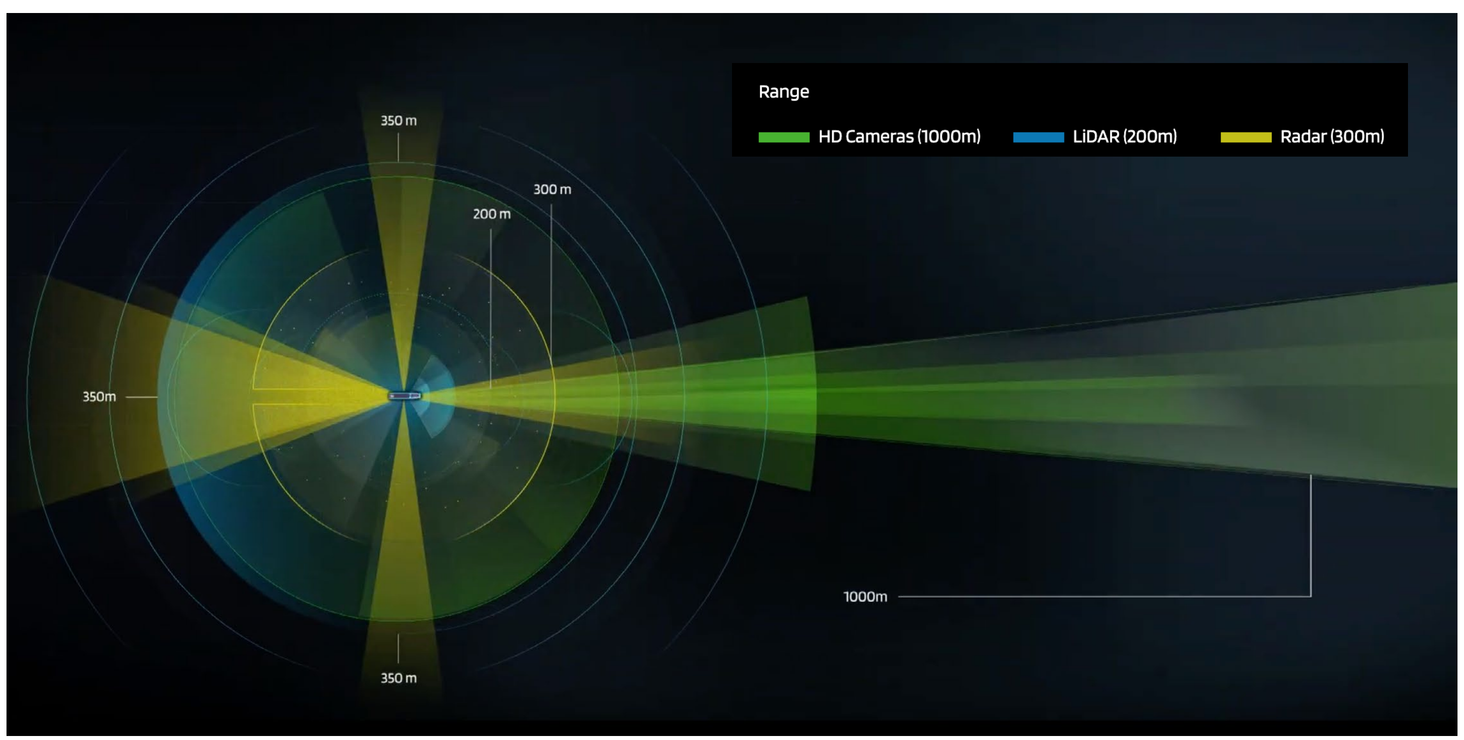
TuSimple believes in using cutting edge perception technology to develop the world's safest autonomous truck. We're building a full-stack solution and enabling autonomous trucks to improve shipping times for goods and materials and to make highways safer and less congested. Our system uses an array of perception and localization sensors and data along with our proprietary deep-learning detection algorithms to detect and track objects in real time and make pixel-level interpretations within the field of vision. With this technology, a truck can achieve a decimeter-level of positioning accuracy — even when in a tunnel or under a bridge.

Using our sensor array and deep-learning algorithms, our proprietary artificial intelligence (AI) decision-making system can guide vehicles along a safe and fuel-efficient route based on terrain and real-time road conditions. Our solution has been purpose-built to provide a robust perception system, allowing the decision-making AI to act with high confidence and detection reliability. Our camera-centric perception system operates more safely at highway speeds because the sensor array is optimized for use on Class 8 tractors and provides redundant secondary and tertiary perception, detection, and tracking data. To provide high confidence and reliable long-, medium-, and short-range perception, we use a variety of sensors that allow our system to detect and track objects at distances of up to 1,000 meters. Our light detection and ranging (LiDAR) sensors provide secondary perception and detection at medium- and short-range, while our radar sensors offer tertiary perception and detection at medium- and short-range.

Large trucks, like the Class-8 trucks our system is designed for and used on, require significantly more stopping distance and time than passenger vehicles. At 65 MPH, we believe a large truck perception system requires 300 to 500 meters of perception range, where perception means reliable detection, classification, localization, and tracking. Because a combined and integrated sensor suite that cannot reliably perceive the critical 300- to 500-meter range is not sufficient for a heavy vehicle traveling at highway speeds, we have designed our sensor array to perceive at a much larger distance of 1,000 meters to ensure reliable determination in the critical safety range and added efficiency. Our 1,000-meter perception range allows the autonomous software to make long-range, proactive, and strategic decisions to improve safety and efficiency beyond what other systems can achieve.

In addition to cutting-edge technology and advanced algorithms, it is important that autonomous systems are designed, manufactured, and used in accordance with exceedingly high safety standards. That is why we are building International Organization for Standardization (ISO) 26262 into every aspect of our system, hardware, software, purchasing, and production processes and are designing to meet the stringent ISO/PAS 21448 SOTIF (safety of the intended function). In support of

OUR AUTONOMOUS SYSTEM

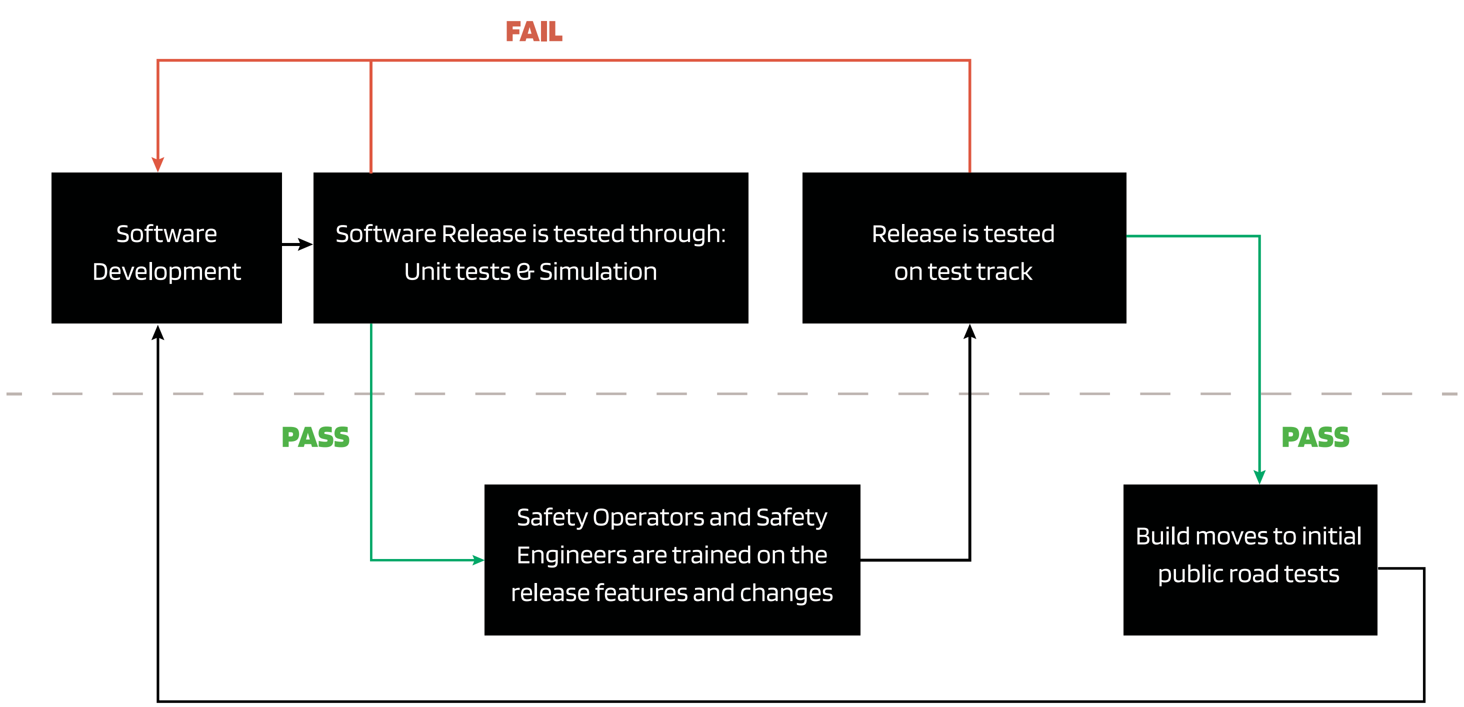


these, we will be registered to International Automotive Task Force (IATF) 16949, the Automotive Quality Management System. IATF will include the required documented supporting processes.

This Voluntary Safety Self-Assessment describes our safety processes and features and the progress we've made implementing them. Our safety assessment follows the U.S. Department of Transportation (DOT) and National Highway Traffic Safety Administration (NHTSA) guidelines laid out in Automated Driving Systems 2.0: A Vision for Safety and is organized in two parts. In this first chapter, we introduced TuSimple, our autonomous driving system, and our approach to safety. In the next chapter, we address the 12 safety elements that the DOT and NHTSA highlight in their guidelines.

CHAPTER 2
ELEMENTS OF SAFETY

SYSTEM SAFETY



DEVELOPMENT AND TESTING CYCLE

The primary goal of our autonomous system is to reduce the danger posed to humans around us. By removing the human operator from our commercial product, we can eliminate errors such as those caused by driver fatigue or distraction. We also continue to evaluate the performance of our system throughout the development and test cycle to identify improvements which are then tested, verified, and included in software updates on all of our trucks. Unlike autonomous systems that are designed for vehicles that carry passengers, our system will be capable of operating without human intervention. Because our system will operate without occupants, our design is primarily concerned with the safety of other drivers in its operational environment.

We understand the importance of using a System Safety approach to eliminate unreasonable safety risks and to mitigate risks that cannot be fully eliminated. We've incorporated well-established standards and processes into the design of every element of our autonomous system. We adhere to internationally recognized standards including relevant standards, recommended practices and guidance from the DOT, aerospace, and military to inform the design, sourcing, verification, and validation of every element of the autonomous system. Following the process outlined in ISO 26262 (Functional Safety – Road Vehicles), we begin by engaging in a requirements analysis to clearly develop the Item Definition. This becomes the basis for the Hazard Analysis and Risk Assessment (HARA) to identify Safety Goals and assign Automotive

SYSTEM SAFETY

ISO 26262	Functional Safety – Road Vehicles
IATF 16949	Automotive Quality Management System
ISO/PAS 21488	Road Vehicles - Safety of the Intended Functionality

STANDARDS WE UTILIZE

Automotive Safety Integrity Levels (ASIL) to every identified hazard and risk so that we can design, build, and implement mitigation, redundancy, and/or ASIL decomposition strategies that will avoid potential failure modes or mitigate the negative consequences of a potential failure.

In addition, we are referencing additional state-of-the-art safety standards and guidelines, such as ISO 21448 Safety of The Intended Function, UL 4600 Standard for Evaluation of Autonomous Products, and industry research papers and studies from leading automotive companies and academia with efforts to develop safety envelopes around the development, testing, and deployment of machine learning algorithms. Furthermore, we are implementing progressive safety methodologies used in aerospace and military to effectively analyze the high level of complexity of our software, such as System Theoretic Process Analysis.

Our Functional Safety and Quality team is led by safety experts with decades of experience in the automotive industry. This team is directly responsible for all safety-related issues and helps lead the engineering teams through detailed and rigorous fault-tree analysis, Failure Mode and Effects Analysis (FMEA), and all system testing and validation. For more information about our specific testing and validation strategies and practices, refer to the Validation Methods section in this document. TuSimple has a robust safety program regarding DOT compliance and public safety standards, TuSimple has taken the initiative to hire two safety experts, a DOT expert and a retired law enforcement executive who are Subject Matter Experts (SMEs) in their areas of expertise.

DOT safety and compliance standards are overseen by a DOT expert. TuSimple is building pre-launch inspection protocols with the support of third-party auditors that rise to the level of the commercial airline standards and meet or exceed minimum inspection requirements set forth by the Federal Motor Carrier Safety Administration (FMCSA), DOT and Commercial Vehicle Safety Alliance (CVSA). All drivers have daily, weekly, and monthly reviews of their performance, and any safety violations are addressed quickly by our SMEs. TuSimple sets the bar higher than CVSA/FMCSA standards to ensure we are one of the safest fleets on the road.

OPERATIONAL DESIGN DOMAIN

We are developing an automated driving solution for trucks that will operate at SAE Level 4 (L4). An L4 autonomous vehicle is able to operate autonomously without a driver present only within a well-defined operational design domain (ODD). Autonomous systems, much like human drivers, have limitations that affect how well they perform in a variety of situations. The ODD for an L4 autonomous system defines its operating limitations and excludes scenarios and situations for which an effective technical solution has not yet been validated. For instance, a system might not be able to meet performance requirements on snowy, high-grade, mountainous roads, so the system would not be authorized to operate in that domain. ODDs can be extremely broad (such as interstate highways in clear conditions) or extremely narrow (such as a defined segment of a specific highway during certain hours), but they must be specific and use clear and unambiguous statements to define the limits under which the system is allowed to operate. ODDs must take into account road types and conditions, weather, topographic features, speed limits, and traffic laws, and other jurisdictional regulations.

Our ODD definition includes highways and surface streets from depot to depot during night and day and during inclement weather. It also includes parameters for road types, geographic and topographic features, speed limits, laws, and regulations. Our commercially deployed autonomous system is intended to operate under a variety of conditions and will have an ODD that confines the system to previously mapped routes validated to the ODD.

OBJECT AND EVENT DETECTION AND RESPONSE

Every driver relies on their senses to perceive the world around them. They use the information acquired through their senses, along with their previous experiences and knowledge, to predict the behavior of others on and around the road and to make driving decisions. Autonomous systems are no different. Our autonomous system uses sensor solutions to perceive and determine a safe and appropriate vehicle command. Our system detects, tracks, and predicts the behaviors of objects. Our system tracks and resolves dynamic objects to ensure that they are no longer associated with risks. Our autonomous system uses these inputs to make appropriate driving decisions for the given situation.

Our autonomous system is capable of identifying and tracking various static and dynamic objects it encounters. We use an array of sensors including high definition cameras, LiDAR, radar, ultrasonic sensors, GPS, inertial measurement units (IMUs), and audio sensors for long-distance sensing in a high-speed environment under a variety of conditions. The distance penetration and clarity of our sensor solution is necessary to provide the time and space for a tractor trailer to safely and smoothly complete maneuvers. In addition to the high-integrity detection in the 300- to 500-meter range that our sensor suite provides for safety at highway speeds, our 1,000-meter forward camera extends our system's range by an additional 500 meters, which allows our planning system to make the safest and most efficient decision possible.

We collect massive amounts of real-world sensor data from our trucks which we use to train the autonomous system to detect and classify objects it could encounter and to anticipate the behaviors of detected objects. Our robust prediction system considers future actions of every detected object in the environment. It assigns probabilities to each potential action for each detected object and uses this set of predictions to choose and execute a trajectory that maximizes the probability of a safe outcome. This allows us to have the safest possible course of action available to the autonomous system, depending on the actions of other drivers and pedestrians and the surrounding infrastructure.

FALLBACK (MINIMAL RISK CONDITION)

No automated driving system can be entirely free from faults, potential failures, or changes in conditions that might place it outside of its operational design domain. Our automated driving system is designed to identify and safely react to these events. To safely react to situations that limit the autonomous system's capabilities or changes in roadway, weather, or other conditions outside the system's operational design domain, the system must be able to detect the critical event or change in conditions and to perform a fallback, or minimal risk condition (MRC), maneuver in response. Our system constantly monitors the health of every safety-critical component and validates all data and timestamps through checks and redundancies to detect scenarios in which an MRC maneuver is required.

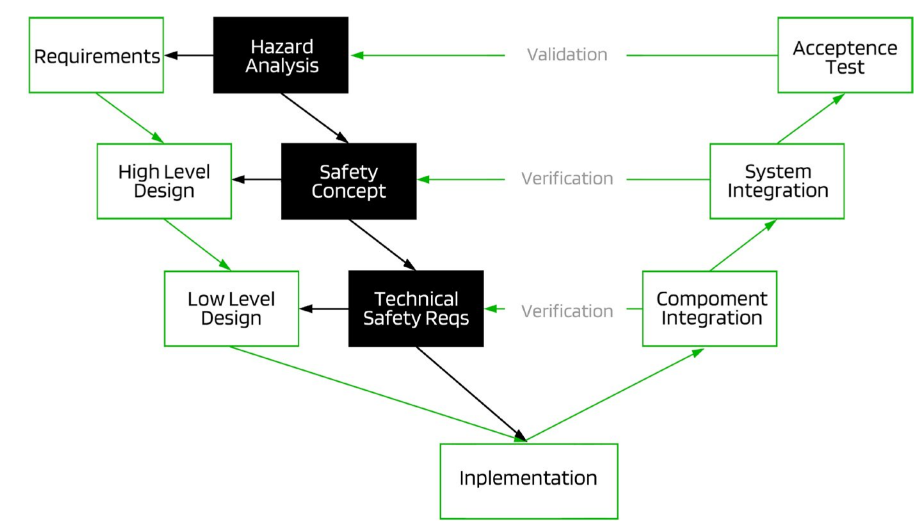
During the development phase, our automated driving system will recognize and attempt to perform most MRC maneuvers, but in some cases the Safety Operator will be asked to assume control of the vehicle. TuSimple's Safety Operator program, which includes training, testing, continuous education, monitoring and strict policies, combined with the design of TuSimple's development phase automated driving system, help to ensure that this is a highly controllable disengagement of the autonomous system. After the system is functionally complete, automated MRC maneuvers have met functional safety goals, and the system has been validated, the Safety Operator will not be required. Instead, our commercial-intent autonomous system will detect both internal system faults and external conditions to provide input to the Functional Safety module which will choose an appropriate Functional Safety response and, when necessary, perform appropriate actions to achieve an MRC ranging from logging an event for degradation analysis through performing a safe emergency stop and park. With fail-operational functionality, our system can determine whether to continue to operate under more restricted operational parameters or if it must stop operating immediately.

We're building fault-tolerance and fail-operational capability into our autonomous system by using proven practices and frameworks developed for automotive, aerospace, and military applications to improve the reliability and safety of our autonomous system. To reduce the likelihood of system failure, we design for reliability, self-diagnostics, self-correction, and redundancy where necessary. We perform extensive testing to evaluate the reliability of every component of the system and implement 3-tier redundancy whenever possible. We also perform fault analysis to develop a fault mitigation plan that covers the risks identified in our HARA. All safety mechanisms, faults, and fault tolerances are validated as is required to meet our functional safety goals

VALIDATION METHODS

Throughout the system design process, we identify functional performance requirements and the hazards and risks that could result from misbehaving functions. We perform a full Design Verification Plan and Report (DVP&R) of functions, maneuvers, scenarios, and degradation scenarios. Electrical/electronic (E/E) devices receive full rational automotive tests, including electronic emissions. To limit public exposure to unnecessary risk, we use computer simulation testing before moving to test track/proving ground testing, then finally move to road-level testing with Safety Operators after the system has passed the previous two phases of testing. Data from each testing phase is analyzed and used to develop further improvements to the system.

Hardware components, including sensors, motherboards, graphics processing units (GPUs), and central processing units (CPUs) are tested for their reliability and their performance before integration into our on-vehicle system. Similarly, each software module must pass rigorous regression tests including intensive simulation-based tests that verify the performance of the code against previous iterations before it is installed on our vehicles. After the individual modules and components pass their respective unit tests, we perform a series of simulations and closed-road track tests to verify the performance of the system. Only after the system has successfully passed the unit, simulation, and closed-road track tests is it allowed to operate on public roads. All public road tests of our developmental systems are conducted by a team of our Safety Operators and Safety Engineers. Whenever a new software release is made available to the TuSimple fleet, our Safety Operators and Safety Engineers are provided with detailed system behavior-oriented release notes and face-to-face meetings are held with the development engineering teams to review the changes and discuss their implementation. To pass our verification and validation testing, each update to our system must achieve stringent reliability and confidence levels that are derived from well-developed automotive industry standards.



VERIFICATION AND VALIDATION

We follow the design V-diagram with the design creation from system to component on the left side of the V and the verification and validation from the component to the system on the right side.

VALIDATION METHODS

Safety Operators

During the development period, our autonomous Class 8 trucks are operated by a 2-person team consisting of a trained Safety Operator and a Safety Engineer. Our Safety Operators are all CDL Class A licensed drivers who are responsible for maintaining control of the vehicle at all times, disengaging the autonomous system when necessary, and manually operating the vehicle in the case of an autonomous system disengagement.

Whenever the system will be in autonomous mode, the Safety Engineers are responsible for communicating road and system information to the Safety Operator, monitoring the autonomous system, and recording notes about system and road conditions by voice recording and a laptop. Our Safety Operator will continuously confirm and verify all road conditions, traffic patterns and potential risks with the Safety Engineer in real time, remaining vigilant throughout the drive. While driving, all TuSimple trucks ensure safe operation by using electronic logging devices, real time driver alerts, inward and outward facing cameras and Advanced Driver Assistance Systems (ADAS) from industry leading third-party vendors.

Hiring and Qualifications

Before Safety Operators are hired they must pass a background check, have a clean driving record, prove they possess a CDL Class A license, be Smith System certified, and pass a road test administered by the Lead Safety Operator. Safety Engineers must also pass a background check, have a clean driving record, and pass a series of on-site interviews where they are asked to display their engineering and critical thinking skills by responding to a number of challenging scenarios.

VALIDATION METHODS

Safety Operators

Training Program for Safety Operators and Engineers

The TuSimple autonomous vehicle operation training program is designed for the Safety Operators and Safety Engineers to operate the autonomous vehicles using the guiding principles of safety, communication, and teamwork. The classroom learning objectives cover the company's safety policies, procedures, and practices, and vehicle inspection and emergency protocol. To help prioritize system safety issues, the Safety Engineers are required to take the TuSimple ASIL-Based Prioritization System (ISO 26262). To effectively isolate potential vehicle safety issues during potential pre- or post trip safety inspection failures, Safety Operators and Safety Engineers are trained on the TuSimple Vehicle Lockout and Tagout policy course meeting OSHA's Control of Hazardous Energy standard.

We ensure the classroom to job knowledge transfer through extensive practical training of Safety Operators and Safety Engineers via mission observations, job shadowing, closed track training, and hands-on training. Our trained instructors provide continuous coaching and mentoring based on rigorous evaluation of Safety Operator and Safety Engineer performance.

VALIDATION METHODS

Safety Operators

Continuous Education

Safety Operators and Safety Engineers hold debrief meetings after road tests to discuss system performance, identify corner cases and unusual scenarios, and provide feedback to product and engineering teams. Whenever a new software release is made available to the fleet, Safety Operators and Safety Engineers are provided with detailed, system behavior-oriented release notes and attend face-to-face meetings with the test engineering team to review changes and discuss their implementation.

Strict Policies and Monitoring

Safety Operators and Safety Engineers are expected to follow all company safety policies. The cabin's audio and video recordings are constantly reviewed to ensure both Safety Operators and Safety Engineers are following company policies. Violations of company safety policies or changes to driving records may result in disciplinary actions, ranging from training and testing to termination. For example, Safety Operators may only use hands-free mobile devices while the vehicle is on the road, unless they are parked or immobilized and need to contact emergency responders. Additionally, Safety Operators must always keep their hands poised near the steering wheel and keep their feet poised near, but not on, the pedals.

HUMAN MACHINE INTERFACE

When commercially deployed, our autonomous system is intended to function within its operational design domain without human intervention. Therefore, the most important aspects of our Human-Machine Interface (HMI) are the external and public elements that help other road users (including pedestrians, cyclists, law enforcement and first responders) interact with our autonomous trucks. We are designing an external-facing HMI to be intuitive and easily understood by other road users.

Because our autonomous system is intended for use on a variety of third-party Class 8 tractors, it relies on standard interfaces and indicators for other road users. The system uses the OEM-installed tractor lights (cabin, hazard, head, turn, and tail). It also uses the same side and tail lights installed on the trailers it hauls. These signals are all readily understood by other road users and require no further training or education on the part of the public. The system does, however, have some unique indicators and interfaces on the exterior of the tractor. The commercial autonomous system will indicate to other road users that it is operating autonomously. We are working with regulators and other developers to standardize how the system will indicate its autonomous status. We are also working with regulators, state agencies, and other public safety entities to develop and improve the way first responders interface with the autonomous system, so they are informed about the system and prepared when they need to interact with the autonomous vehicle. We will also publish a detailed interaction guide for first responders and public safety officers.

During development, we provide an HMI for use inside the vehicle, intended for use by the Safety Operators and Safety Engineers working on the autonomous system. Our development stage HMI monitors the autonomous system and annotates recorded road and system data. The development-stage HMI also provides passengers with the autonomous system's perception, prediction, and planning information. The HMI displays the detailed map, tracked objects and vehicles, and the predicted behaviors of other road users. It also audibly announces turns, lane changes, and other pertinent maneuver decisions. During the development phase, the HMI allows the Safety Operator to disengage the autonomous system in any of the following ways:

- Pressing the Disengage button on the steering wheel
- Depress the accelerator or brake
- Turning the steering wheel

The development phase HMI includes a system that indicates the autonomous system's status to the Safety Operator. It indicates if the system is engaged, ready to engage, in an error or warning state, unable to engage, or disengaged. However, all other detailed system information comes from the Safety Engineers, so Safety Operators are not monitoring the detailed HMI or at risk of on-screen distractions.

VEHICLE CYBERSECURITY

Cybersecurity is a critical element of our system safety approach. To protect our automated driving system from malicious attacks, we design protections that will help prevent attacks and implement mitigation strategies to minimize the potential impact of any cyber intrusion. We work with cybersecurity specialists to create security protocols that protect vulnerabilities in the autonomous system and all features, components, or tools that interact with the autonomous electronics. We are actively developing cybersecurity controls based on ISO 21434 for automotive cybersecurity. ISO 21434 establishes a progressive and continuous strategy to evaluate and monitor automotive system architectures for cybersecurity risks, assign cybersecurity goals to identified risks, develop technical controls based on those goals, then continuously monitor production systems for future facing security concerns. Threat modeling is actively conducted internally and we also leverage third-party automotive cybersecurity companies to provide threat analysis and risk assessment (TARA) based on the guidance in ISO 21434 and WP.29. The product security goals are derived from the risks identified and security controls are established to mitigate prioritized security risks.

Our cybersecurity protocols are designed to isolate and protect all onboard systems that communicate with the outside world through a variety of strategies, including encrypted communications and logical service isolation. If an MRC maneuver is triggered or an abnormal software event is detected, remote monitoring services are notified and pertinent data is automatically recorded to electronic logs so that the system events can be reconstructed.

Any thorough approach to cybersecurity protections must also address the potential for physical attacks. To mitigate the risk of physical attacks against our autonomous system, we closely monitor and limit direct access to the system's hardware components. Our system is designed with physical enclosures that inhibit third-party access to hardware components, including physical tamper detection. We work closely with security experts and our partners to review and approve all third-party libraries used in our software and hardware. We also review our internal processes and practices so that they align with the recommendations for cybersecurity from NHTSA and the Automotive-Information Sharing & Analysis Center (Auto-ISAC).

CRASHWORTHINESS

When commercially deployed, TuSimple trucks are designed to haul freight without human intervention, therefore a human driver or other occupant will not need to be present in the vehicle when operating within the ODD. During the development phase, however, we do have Safety Operators, Safety Engineers, and other occupants in the vehicle and we anticipate that there will be times when commercially deployed trucks will be operated by a human driver outside of the ODD. To assure the safety of these vehicle occupants, we evaluate the crashworthiness and passenger safety implementations of our autonomous vehicles through:

- the crashworthiness and passenger protection features of the base vehicles
- the crashworthiness and passenger protection features of our autonomous system and modifications.

CRASHWORTHINESS OF BASE VEHICLE

We are developing, testing, and validating our autonomous system on Class 8 trucks manufactured by Peterbilt and Navistar International. These tractor platforms comply with all applicable Federal safety standards and offer numerous supplemental safety features, including collision mitigation systems, radar-assisted rear end collision avoidance, Adaptive Cruise Control (ACC), lane departure warning, improved air disk brakes, and airbags and rollover seat protections. We do not modify any of the existing safety or collision mitigation systems of our test vehicles and we work closely with our OEM suppliers to ensure that our system does not interfere with any of the intended functions of their systems.

CRASHWORTHINESS OF AUTONOMOUS SYSTEM AND MODIFICATIONS

We do not modify or disable any of the OEM installed safety features or functions. We only modify our autonomous vehicles to install and operate the autonomous sensors and system hardware. During the development and prototyping phase, we also modify selected test vehicles' sleeper cabins to accommodate additional passengers. The sleeper cab modifications to accommodate additional passengers will only be present during the development phase.

POST-CRASH ADS BEHAVIOR

Should a TuSimple truck operating in autonomous mode be involved in a crash, it will immediately initiate a fallback, or MRC maneuver appropriate to the severity of the incident. Depending on the severity of the incident and the vehicle's functional capabilities, the autonomous system will immediately and simultaneously complete the following actions, using redundant systems to complete the actions, if necessary:

- Apply brakes and come to a complete stop or slowly move to the closest safe stopping area (like the shoulder on an interstate highway).
- Activate the vehicle's hazard lights.
- Alert the TuSimple operations center and request assistance*.
- Automatically record detailed system and vehicle data surrounding the incident to an electronic log.

*We are coordinating with regulatory bodies and first responders to develop an appropriate notification protocol.

We will provide emergency responders with all necessary information for them to safely interact with the self-driving vehicle at the scene of a crash and during normal operations. We will also set up a toll-free hotline for first responders and other road users so that they may communicate directly with company representatives regarding the self-driving vehicle's post-crash and normal operation.

In addition to the actions taken by the ADS in the event of a crash, we will initiate a fleet-wide response. During development, the fleet-wide response will be to immediately notify all Safety Operators to have them disengage the self-driving system and take manual control of the trucks they are operating. Post-development, TuSimple trucks in commercial operations will immediately notify our central management hub in the event of a crash, which will initiate an investigation into the root cause of the crash.

Finally, in the event of damage to one of our self-driving vehicles, a complete system test will be performed before it is allowed to operate on the road again.

LAW ENFORCEMENT LIAISON PROGRAM

Our law enforcement liaison program is critical for TuSimple to meet the safety standards we require to lead the industry. We have met and partnered with law enforcement professionals and other first responders to gain knowledge on best practices for highway safety and post-collision investigations, how law enforcement will interact with fully autonomous commercial vehicles, and standards for in-motion review by officers and CVSA inspectors for the health and safety of our vehicles. This level of collaboration with law enforcement is the first of its kind in this space and it's required to ensure TuSimple is a leader in safety.

COMBATING HUMAN TRAFFICKING

We also participate on two committees and boards for CVSA to include the ADS CMV working group and the Human Trafficking subcommittee. As we continue to grow the network we will continue to meet with and collaborate with our private and government stakeholders to ensure we are involved in the conversations and help set the safety standards for autonomous commercial motor vehicles.

We have a very strong commitment to combat Human Trafficking. We have implemented a mandatory training program from Trucker Against Human Trafficking for all TuSimple drivers. Additionally, all trucks are equipped with this bumper sticker to signal our support and highlight available resources.

DATA RECORDING

During the development phase, our autonomous system records and logs all autonomous system, vehicle network (such as the CAN-bus), and vehicle control data. This data is critical to the continuous improvement of our autonomous system. The data we record is transmitted to teams of TuSimple engineers and backed up after every data collection or testing trip. This real-world data is then used to test and train the autonomous system on varying road, weather, lighting, and control situations. Because we record all sensor, vehicle control, and CAN-bus data, we can continuously run simulations with our autonomous software against previous real-world experience to ensure that the software continues to improve. Similarly, this data can be used to create and inform new simulation scenarios that we use to verify and validate the autonomous system.

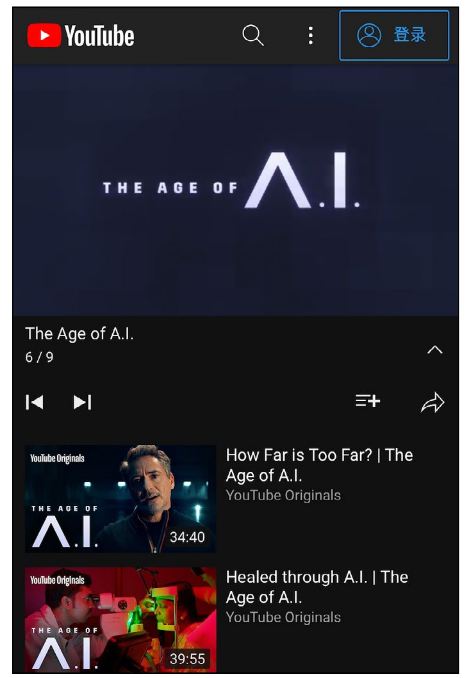
Post-development, commercially deployed systems will record the same data recorded during the development phase. We are working with other ADS developers and appropriate regulatory bodies to design and implement data recording standards that can be used for all autonomous vehicles, and our system will comply with any relevant data recording requirements.

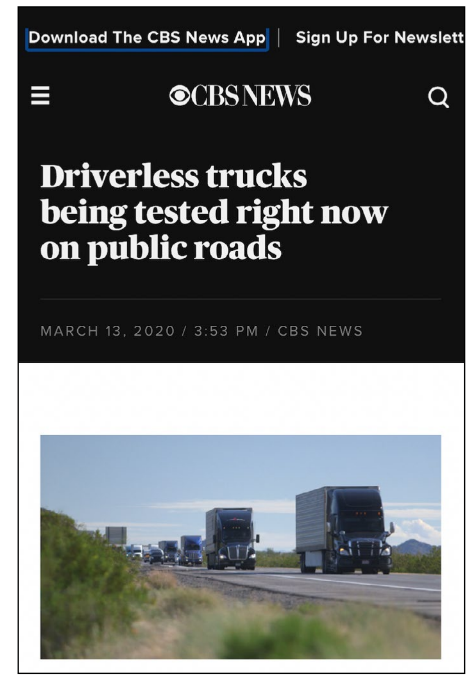
CONSUMER EDUCATION AND TRAINING

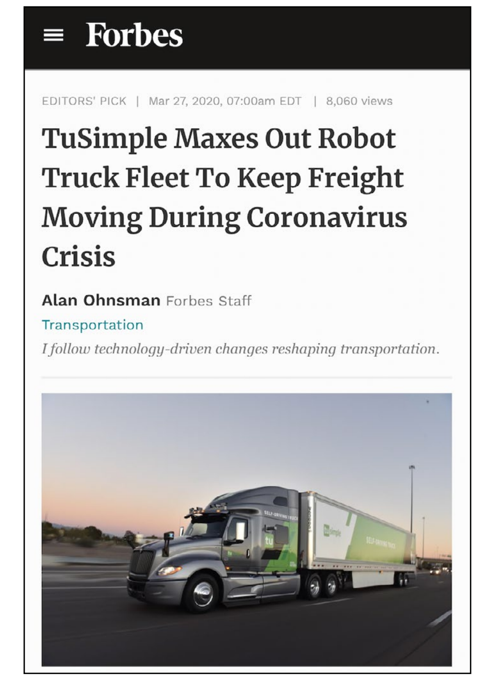
The day-to-day experience for the general public who will interact with TuSimple's autonomous trucks will not be noticeably different from their current interaction with long-haul logistics carriers' manually operated trucks. To keep the public informed about autonomous trucks and address any concerns about how to properly interact with them, we will publish educational materials for public consumption as our autonomous system matures and becomes commercialized. These materials will be made available through traditional media outlets and through our website.

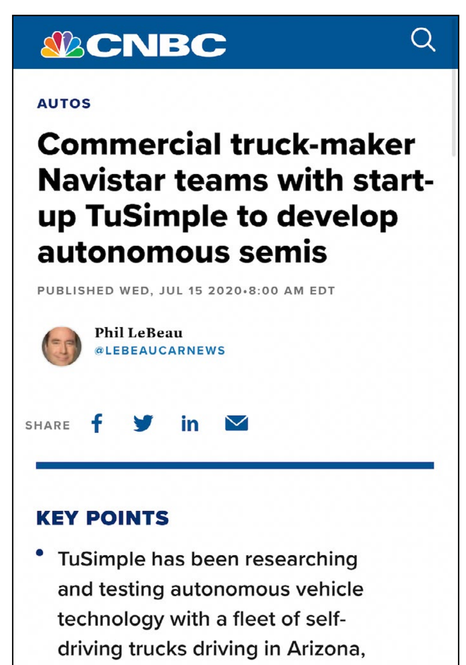
TuSimple is also working closely with our logistics partners to inform the employees who will interact directly with the autonomous system about the system's features and limitations. The loading and unloading of their trailers will remain unchanged and we will provide direct in-person and documented training for any changes that are required with regard to preparing the trailer for shipment. We are also partnering and working closely with a number of fuel, parking, and rest location operators to develop procedures for refueling and parking autonomous trucks.

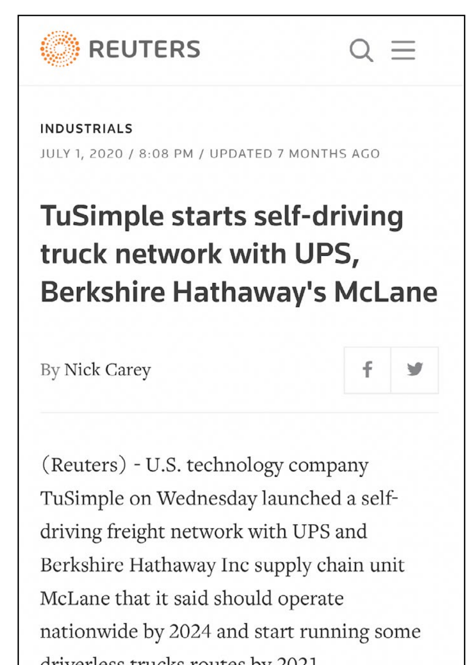
TUSIMPLE IN THE NEWS

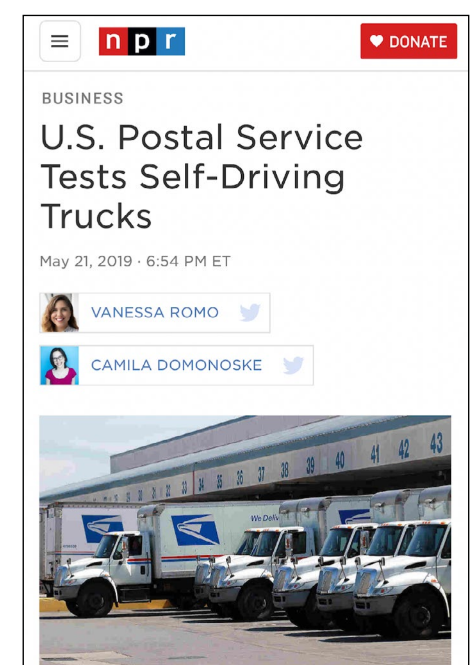


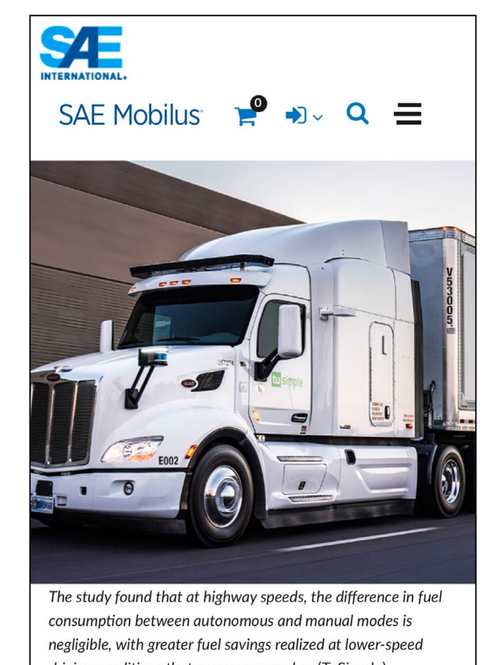




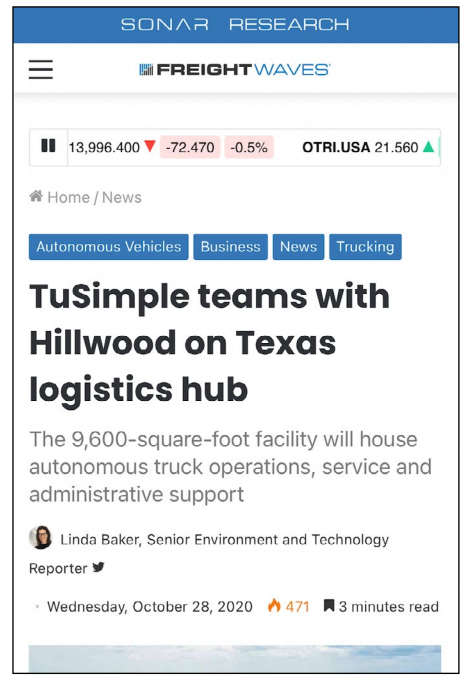








TUSIMPLE IN THE NEWS

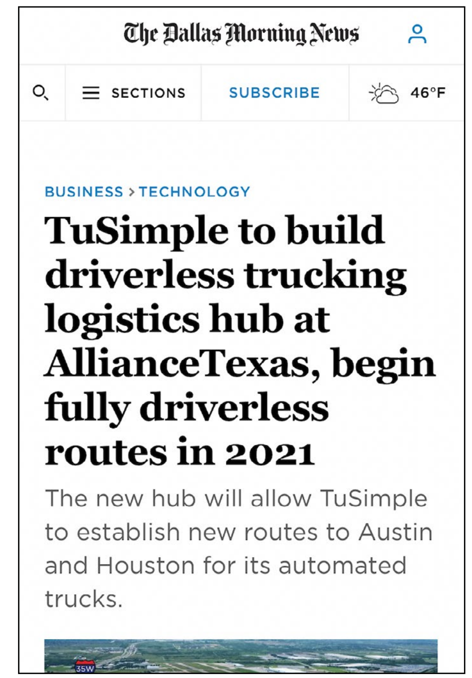

SONAR RESEARCH
FREIGHTWAVES
Home / News
Autonomous Vehicles | Business | News | Trucking

TuSimple teams with Hillwood on Texas logistics hub

The 9,600-square-foot facility will house autonomous truck operations, service and administrative support

Linda Baker, Senior Environment and Technology Reporter

Wednesday, October 28, 2020 · 471 · 3 minutes read


The Dallas Morning News
SECTIONS SUBSCRIBE 46°F
BUSINESS › TECHNOLOGY

TuSimple to build driverless trucking logistics hub at AllianceTexas, begin fully driverless routes in 2021

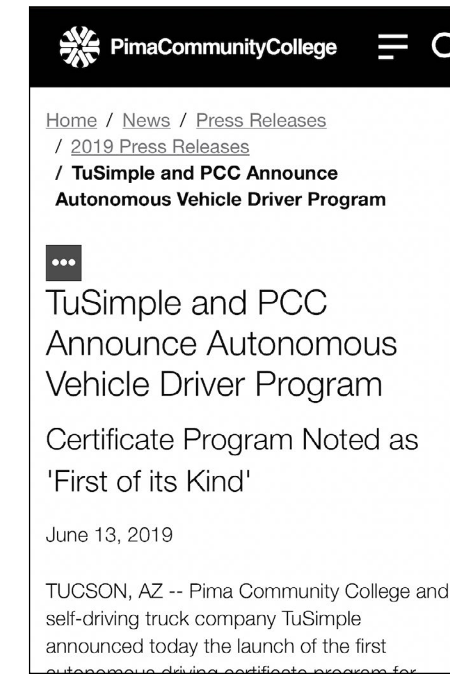
The new hub will allow TuSimple to establish new routes to Austin and Houston for its automated trucks.


TuSimple
15,462 followers
1mo

TuSimple joined the Arizona Cardinals and the Arizona Pet Project this past weekend to distribute pet food to families in need who have pets to feed. Special thanks to Jay Lau and Maureen Fitzgerald for volunteering their time for such a worthy cause.

#arizonapetproject #tusimple #autonomoustrucks

174 · 6 comments
Like Comment Share Send


PimaCommunityCollege
Home / News / Press Releases / 2019 Press Releases / TuSimple and PCC Announce Autonomous Vehicle Driver Program

TuSimple and PCC Announce Autonomous Vehicle Driver Program

Certificate Program Noted as 'First of its Kind'

June 13, 2019

TUCSON, AZ -- Pima Community College and self-driving truck company TuSimple announced today the launch of the first

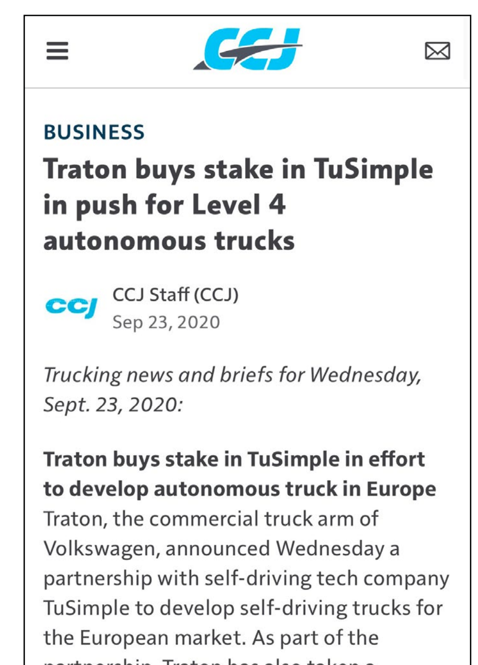

Tweet
TuSimple
@TuSimpleAI

TuSimple was happy to support the local community by sending an autonomous truck to the Junior League of Phoenix's Touch-a-Truck event on Saturday, November 7th. Proceeds from the event support local community programs. Special thanks to volunteers who supported this fun event.


HDT Truckinginfo
News Equipment Fleet Management Safety
Information Center | Webinars | Update You
EQUIPMENT

TuSimple, ZF Partner on Mass-Produced Autonomous Truck Technology

March 26, 2020 • by HDT Staff


CCJ
BUSINESS

Traton buys stake in TuSimple in push for Level 4 autonomous trucks

CCJ Staff (CCJ)
Sep 23, 2020

Trucking news and briefs for Wednesday, Sept. 23, 2020:

Traton buys stake in TuSimple in effort to develop autonomous truck in Europe

Traton, the commercial truck arm of Volkswagen, announced Wednesday a partnership with self-driving tech company TuSimple to develop self-driving trucks for the European market. As part of the partnership, Traton has also taken a

FEDERAL, LOCAL, AND STATE LAWS

Our system safety approach requires that our autonomous system be capable of meeting or exceeding all federal, local, and state requirements and standards. We've also designed the autonomous system to follow all applicable laws. Our detailed ODD and capable OEDR system work in conjunction to cross reference all road rules and ensure that the autonomous system follows the appropriate laws and rules of the road. We incorporate road sign information into our detailed maps, such that the map contains information that informs the autonomous vehicle's speed limit or lane assignment. This information is cross-referenced with ground-truth sensor data to ensure compliance with all applicable laws. For example, when our map indicates that the autonomous vehicle is operating in a solid line lane, the OEDR system confirms the presence of solid lane lines and the autonomous system knows that it cannot legally change lanes.

Any modifications we make to the base vehicle in our commercial system will meet all applicable Federal Motor Vehicle Safety Standards (FMVSS), or we will seek an exemption to the standard following the NHTSA process, which requires that we demonstrate that our system offers the same or greater level of safety as a vehicle meeting the standard. Similarly, we are committed to ensuring that our autonomous vehicles are correctly licensed, registered, insured, and maintained.

TuSimple joined the NHTSA AV Test Initiative and other state AV related projects because we believe the only way for the public to trust AVs is to be transparent and collaborative with our government partners. TuSimple works closely with both state and federal partners on the testing and deployment of AV Truck technology. The CVSA, FMCSA, and industry partners have been integral in developing recommendations for law enforcement interactions and inspections. TuSimple will continue to work closely with the law enforcement community to develop safest electronic inspection in the industry.

As a USDOT authorized carrier for the TuSimple test fleet, we are held accountable for all safety incidents and inspections, similar to other trucking companies.

APPENDIX
Glossary

ACC	Adaptive Cruise Control
ADAS	Advanced Driver Assistance Systems
ADS	Automated Driving System
AI	Artificial Intelligence
ASIL	Automotive Safety Integrity Level
Auto-ISAC	Automotive-Information Sharing & Analysis Center
CAN	Controller Area Network
CDL	Commercial Driver License
CLD	Commercially Licensed Driver
CPU	Central Processing Unit
CVSA	Commercial Vehicle Safety Alliance
DOT	Department of Transportation
EDR	Event Data Recorder
FMCSA	Federal Motor Carrier Safety Administration
FMVSS	Federal Motor Vehicle Safety Standards
GGE	Global Greenhouse Emissions
GGH	Global Greenhouse
GPS	Global Positioning System
GPU	Graphics Processing Unit
HARA	Hazard and Risk Analysis
HIL	Hardware-in-Loop
HMI	Human-Machine Interface
IATF	International Automotive Task Force
IMU	Inertial Measurement Unit
ISO	International Organization for Standardization
KITTI	Karlsruhe Institute of Technology and Toyota Technological Institute
LiDAR	Light Detection and Ranging
MRC	Minimal Risk Condition
NHTSA	National Highway Traffic Safety Administration
ODD	Operational Design Domain
OEDR	Object and Event Detection and Response
OEM	Original Equipment Manufacturer
OSHA	Occupational Safety and Hazard Administration
SAE	Society of Automotive Engineers
TADS	TuSimple Autonomous Driving System

APPENDIX
End Notes

[1] SAE J3016. Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. SAE International, September 2016.

[2] Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, Heavy and Tractor-trailer Truck Drivers, Retrieved March 18, 2019 from https:// www.bls.gov/ooh/transportation-and-material-moving/heavy-and-tractor-trailertruckdrivers.htm.

[3] McNally, Sean. (2018) "Turnover Rate at Large Truckload Carriers Rises in First Quarter. Accelerating Churn Rate Indicates Continued Tightness in Driver Market." Retrieved December 21, 2018 from https://www.trucking.org/article/Turnover-Rateat-Large-Truckload-Carriers-Risesin-First-Quarter.

[4] Costello, Bob (2017). Truck Driver Shortage Analysis 2017. American Trucking Association.

[5] U.S. Department of Transportation. (2018) Federal Motor Carrier Safety Administration Analysis Division: Large Truck and Bus Crash Facts 2016. (FMCSA-RRA-17-016) Washington, DC: U.S. Government Printing Office

[6] American Trucking Association. (n.d.) Reports, Trends and Statistics. Retrieved December 21, 2018 from https://www.trucking.org/News_and_Information_Reports_Driver_Shortage.aspx

[7] American Trucking Association (2018). "ATA's Freight Forecast Projects Growth for Trucking." Retrieved December 20, 2018 from https://www.truckinginfo.com/312756/ atas-freight-forecast-projects-growth-for-trucking.

[8] McNally, Sean. (2018) "New Survey Data Reveals Increases in Driver Compensation." Retrieved December 20, 2018 from https://www.trucking.org/article/New-SurveyData-Reveals-Increases-in-Driver-Compensation

[9] U.S. Department of transportation. (2017) Automated Driving Systems 2.0: A Vision for Safety. https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069aads2.0_090617_v9a_tag.pdf

[10] https://www.drivedifferent.com/

[11] https://www.internationaltrucks.com/support/safety

[12] https://www.peterbilt.com/innovation/safety

[13] U.S. Department of transportation. (2018) Automated Vehicles 3.0: Preparing for the Future of Transportation. https://www.transportation.gov/sites/dot.gov/files/ docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportationautomated-vehicle-30.pdf