EDGE CASE RESEARCH

About Edge Case Research  Manuela
Safety Cases  Noah
Metrics & Hologram  Mark
In the future, autonomous mobility will transport us to work, carry our families and friends to see each other, and deliver the goods we count on every day.

The mission of Edge Case Research is to ensure that everyone stepping into a self-driving car gets a safe ride, and that every autonomous vehicle traveling through our neighborhoods is built safely from the ground up.

We will make this vision a reality, thanks to our expert team, our innovative technology, and our position as a trusted, independent source of best practices for the autonomous mobility market.
Edge Case by the Numbers

- **Founded in 2014** to help customers deliver safe autonomy for automotive, logistics, mining, defense, and aerospace customers.

- **60 people** including experts from Carnegie Mellon, MIT, Duke, Argo AI, Uber ATG, Aurora, GM, Bosch, Amazon, and the U.S. Army.

- **$17M of funding raised** from Chris Urmson, yabeo Venture Tech, ANSYS, Trucks, Lockheed Martin, Liberty Mutual, and Blue Tree Allied Angels.

- **Global operations in Pittsburgh and Munich** with additional personnel in Detroit, Seattle, Washington DC, and California.
Edge Case is the best positioned company in the autonomy industry with the most qualified team to help our customers succeed.
Edge Case provides safety-focused solutions for the validation of BMW’s iNEXT vehicle.

Munich, Germany

Edge Case Research helps the Army build autonomy that it can trust.

Detroit, U.S.

Edge Case solutions help customers of NXP's BlueBox achieve safe self-driving applications.

Austin, U.S.

Uber ATG is collaborating with Edge Case Research to advance self-driving vehicle safety.

Pittsburgh, U.S.
UL 4600 addresses safety principles and processes for evaluating fully autonomous products requiring no human driver supervision.

UL Standards developed this standard in partnership with Edge Case Research, a recognized leader in development of autonomous systems.

In addition to autonomous vehicles, the standard can be applied to products used in mining, agriculture and maintenance as well as other products including unmanned aerial vehicles (UAVs).
Leverages the massive simulation results that all AV companies are compiling.

Validates them with real-world analysis from Hologram, Switchboard, and third party testing tools.

Clearly defines a SOTIF process that incorporates SPIs.

Designed to be ANSI/UL4600 conformant for future L4 autonomy.
Safety Case Adoption

**Uber ATG** - Newly released revision to their “Safety Case Framework” this week

“This version of the Safety Case Framework seeks to incorporate lessons from the UL4600 standard by fully mapping the UL4600 standard to the Framework.”

**PEGASUS** - Argumentation is at the core of their safety strategy

“Therefore, the overarching goal is to create a relevant, coherent and thereby verifiable safety argumentation with integrity in a structured and formalized manner.”
Handling Unknowns

Pegasus: 'It is recommended for further projects to start with the safety argumentation very early in the project to define the contribution of each single work packages to the project architecture and to the argumentation chain of safety'

Field monitoring of safety performance indicators (SPIs) increases confidence in the safety argument

- Evaluate safety case assumptions
- Detect previously unknown effects
- Use high probability, low severity failures in order to find low probability, high severity failures
- Obtain greater confidence over a smaller number of fleet miles
Efficiency of Leading Measure SPIs

Well-defined leading measures allow faster hazard identification and as a result faster hazard mitigation.

Leading measure definition, implementation, and interpretation allow more efficient autonomy function development.
Efficiency of Leading Measure SPIs

Well-defined SPIs of this type are:

- Traced to the safety case
- Traced to safety related events
- Sufficiently high probability for iteration
- Able to be prioritized
- Actionable
Sensor fusion relies on diverse sensing modalities. Monitor for multiple sensors failing systemically.
IEEE P2846 is developing a technology neutral metric for assessing driving safely

- Safe distances based on physics
- Define proper responses to evade dangerous situations

Some question whether rule checkers are viable safeguards in complex ODDs

Either way, these rules can be good SPIs for planners
You can’t avoid what you don’t see, so track the arrival rate of “surprises” for your pedestrian detector.
Examples of edge cases found by Hologram in the real world

Hologram helps customers automate data triage and identify new training data
Run customer perception algorithm on baseline video

Run customer perception algorithm on modified video

Hologram Robustness Analysis

1. Identify scenarios in the dataset where brittle detections occur
2. Run prediction algorithms offline to find detection failures in baseline video
3. Cluster detection failures according to their potential root causes
4. Plan mitigations for the root causes of failures found

(Patent pending)
Data center has far too much information to analyze manually, with more coming each day. Hologram AI intelligently scours the dataset for edge cases.

Human safety analysts review edge case examples.

Edge cases are investigated and categorized by potential root causes.

Automation for edge case detection:

- Weather conditions
- Lighting conditions
- Unusual road users

Standards-based work products:

- MIL-STD 882, SOTIF
- UL 4600, or customized

Kubernetes and Docker support provides flexible deployment options on premises or in the cloud.
Hologram uses the last few frames of brittle pedestrian detection to ascertain that the SUT probably failed to detect the pedestrian now shown in red. **No data labels were required for this calculation.**
Connect with Edge Case Research

- Request Hologram Demonstration
- Learn more on UL 4600
- Start a Pilot Project - Risk Management Analysis, SOTIF & 4600 Analysis
- Check out our resources and Safety Series Podcast

www.ecr.ai