Anatomy of a Robotaxi Crash:
The Cruise Pedestrian Dragging Mishap

September 2024

Prof. Philip Koopman

www.Koopman.us
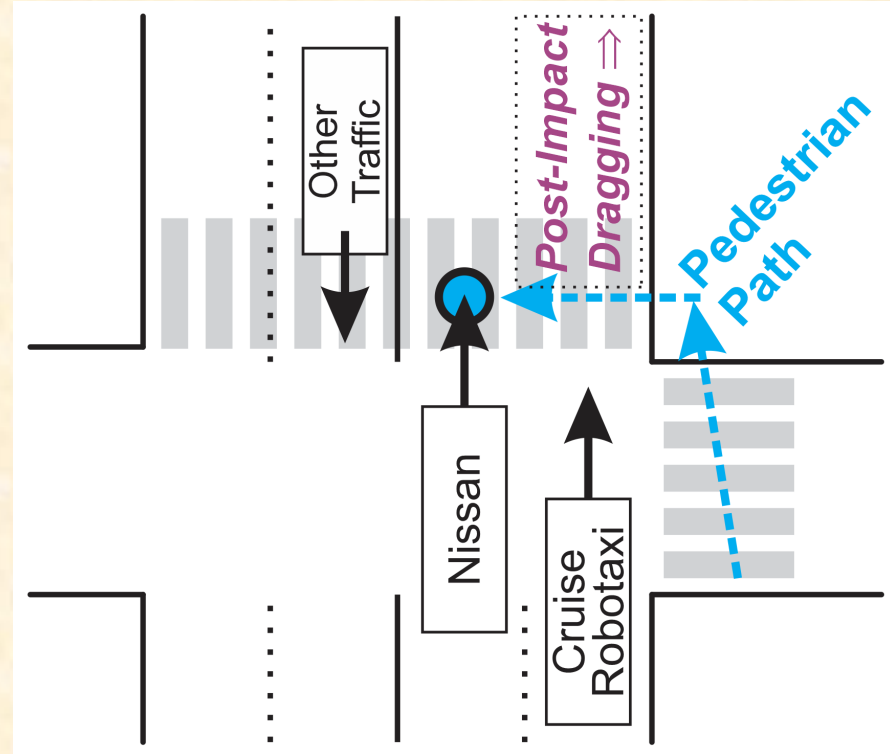
Carnegie Mellon University

Overview

- **San Francisco October 2023 mishap**
  - **Complex crash scenario**

- **What went right & wrong:**
  - **Mishap sequence**
  - **Post-mishap response**
  - **Regulatory response**

- **Observations & lessons**

More details:

https://arxiv.org/abs/2402.06046

REPORT TO THE BOARDS OF DIRECTORS OF CRUISE LLC, GM CRUISE HOLDINGS LLC, AND GENERAL MOTORS HOLDINGS LLC REGARDING THE OCTOBER 2, 2023 ACCIDENT IN SAN FRANCISCO

January 24, 2024

quinn emanuel trial lawyers
quinn emanuel urquhart & sullivan, llp

Cruise AV SF Incident—Pedestrian Collision (Exponent Project 2310645.000)

Technical Root Cause Analysis

Prepared by

Exponent, Inc.
149 Commonwealth Drive
Menlo Park, CA 94025

December 12, 2023

- ■ Cruise-funded: assume best possible conclusions
  - ● Safety improvement recommendations out of scope
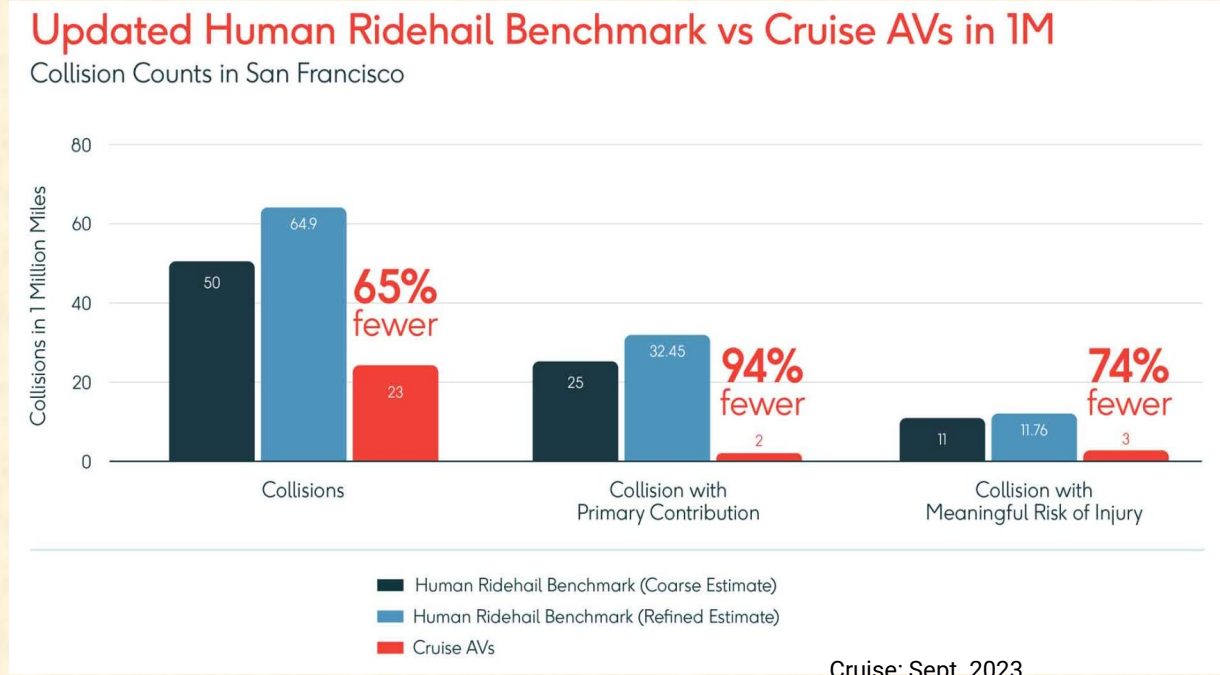
Cruise Marketed On Safer Than Humans

Kyle Vogt ✓
@kvogt

Follow

We ran this full-page ad in @nytimes and several local papers today.

Human drivers aren't good enough. America can do better, and it is time we fully embrace AVs.
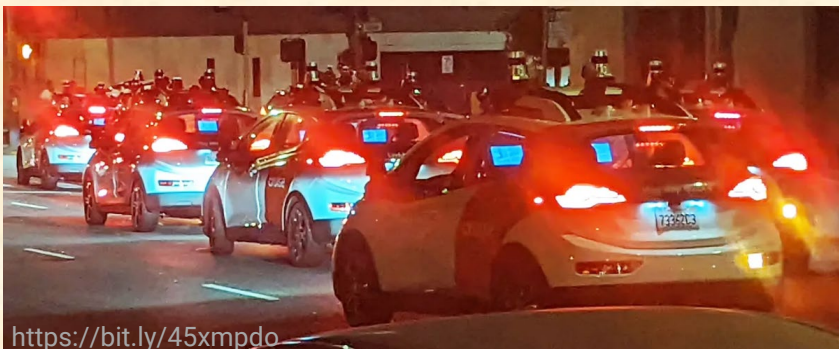
Humans are terrible drivers

42,795 Americans were killed in car crashes last year

You might be a good driver, but many of us aren't. People cause millions of accidents every year in the US. Cruise driverless cars are designed to save lives. Our cars were involved in 92% fewer collisions as the primary contributor.* They also never drive distracted, drowsy or drunk.

Learn more at getcruise.com/safety

*When benchmarked against human drivers in a comparative driving environment - from the Cruise 1 million mile safety report. Fatality statistics estimated by NHTSA.

Last edited 11:45 AM · Jul 13, 2023 · **956K** Views

Comparisons emphasized "at fault" crashes

Updated Human Ridehail Benchmark vs Cruise AVs in 1M
Collision Counts in San Francisco

Legend:
- Human Ridehail Benchmark (Coarse Estimate)
- Human Ridehail Benchmark (Refined Estimate)
- Cruise AVs

Cruise: Sept. 2023.
https://bit.ly/47W1DVR

https://twitter.com/kvogt/status/1679517290847694848

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Multiple Preceding Loss Events

https://bit.ly/49POy27

Aug. 2023:
Injury crash with fire truck.
After service expansion, CA DMV asks Cruise to cut active fleet size in half

https://bit.ly/45xmpdo

**July 2023:**
Robotaxis stuck blocking travel lanes

March 2023
Software defect causes Cruise crash into city bus

https://bit.ly/CarMuniCrash March 2023

Carnegie
Mellon
University

- **Light changes**
  - Vehicles start moving
- **Pedestrian crosses**
  - Stops, blocked by traffic
- **Human-driven Nissan impact**
  - Pedestrian thrown
- **Robotaxi hits pedestrian**
- **Robotaxi stops**
- **Robotaxi starts pullover**
- **Pedestrian dragged 20 feet**
  - Severe injuries; $8M+ settlement

Other Traffic

Pedestrian Stops

Nissan

Cruise Robotaxi
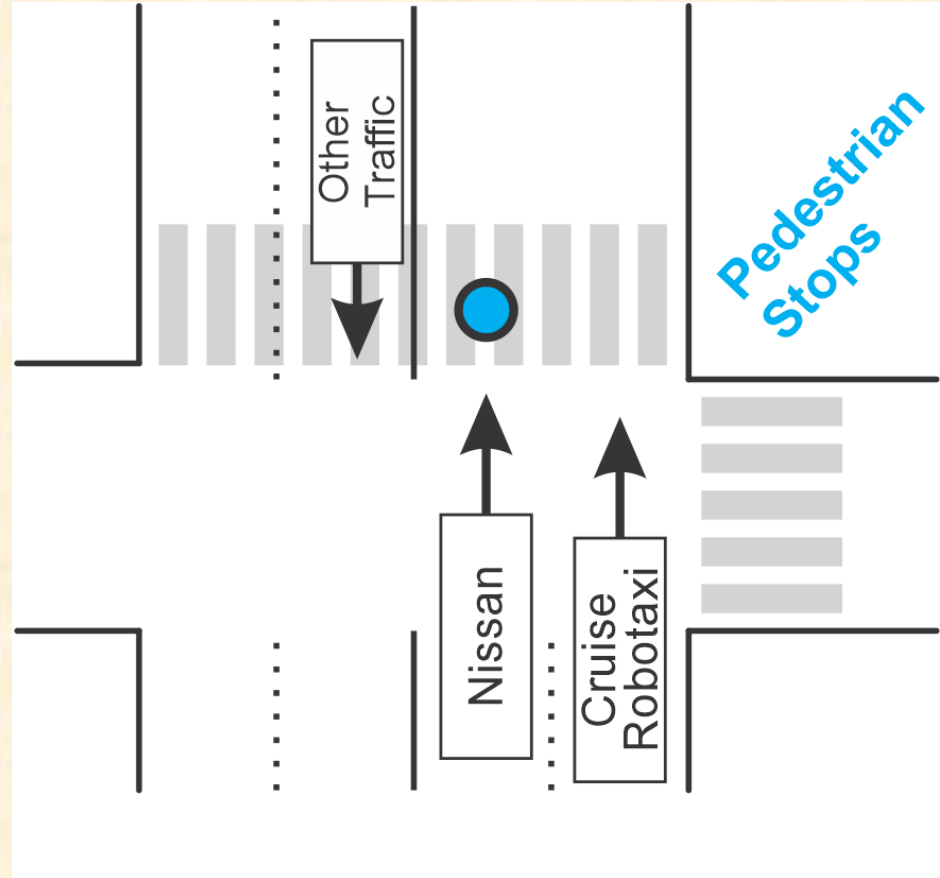
What Went Right

■ **Tracked pedestrian before initial Nissan impact**

■ **Braked for undifferentiated object**
- Occupied space assumed to be pedestrian

■ **Stopped pullover maneuver due to vehicle movement malfunction**

■ **Robotaxi accelerated into pedestrian in crosswalk**

- 5.5 mph ➜ 13.5 mph

■ **California Vehicle Code**

- "The driver of a vehicle <u>approaching a pedestrian within any marked or unmarked crosswalk</u> shall exercise all due care and <u>shall reduce the speed of the vehicle</u> or take any other action relating to the operation of the vehicle as necessary to safeguard the safety of the pedestrian."

No Notion of Other-Vehicle Impact

■ **Cruise's computer driver saw Nissan/Pedestrian impact**

● Tracking showed trajectory intersection of Nissan and Pedestrian

● Camera image showing moment of impact

■ **Robotaxi world model did not recognize significance**

● No notion of other-vehicle collisions

● Did not slow down in recognition of nearby collision happening

Pedestrian Struck

Nissan

Cruise Robotaxi
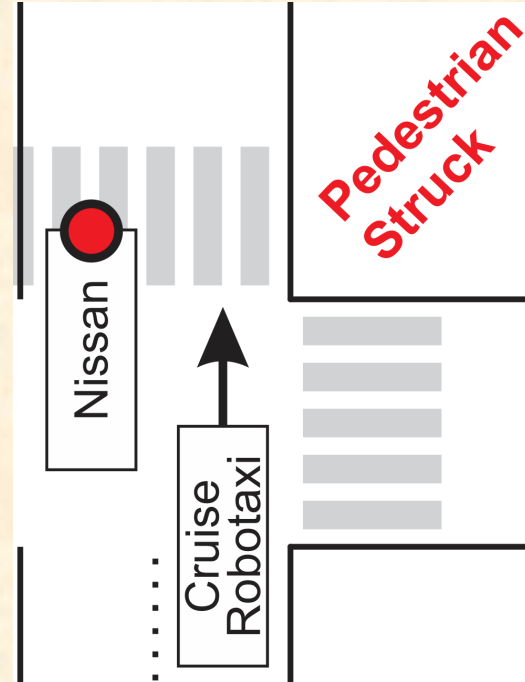
Failure To Track Thrown Pedestrian

■ **Lost reliable detection of pedestrian at/after Nissan impact**

- Intermittent classification
- Intermittent tracking

■ **Could have mitigated impact**

- 2.9 seconds from initial Nissan impact to robotaxi impact
- Full stop possible starting at lane intrusion
 - But only 0.5 mph speed decrease to 18.6 mph

Pedestrian Thrown

Nissan

Cruise Robotaxi
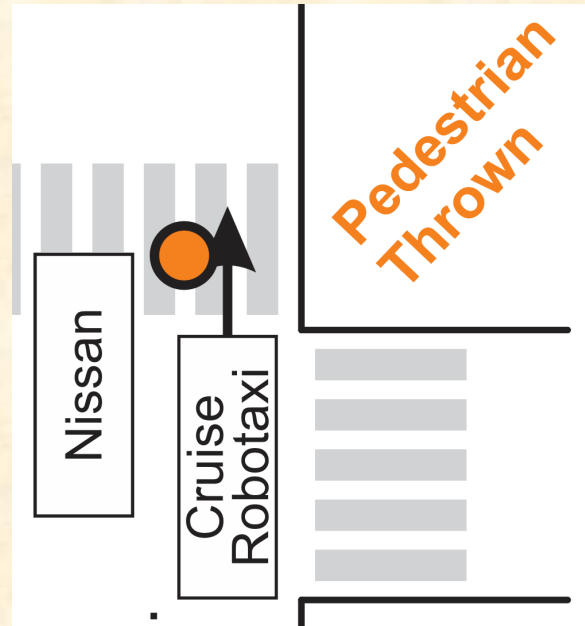
Vanishing Pedestrian

- ■ **Computer driver essentially forgot it had hit a pedestrian**

- ■ **Did not wait for remote assistance**
  - ● Video shows pedestrian on robotaxi hood
  - ● Incorrectly evaluated as side impact – based on unreliable tracking data

- ■ **Inconsistent safety policies**
  - ● "Occupied space" in front assumed to be pedestrian for emergency braking
  - ● Side impact apparently assumed to be vehicle side-swipe

Post-Impact Dragging ⇑

Cruise Robotaxi
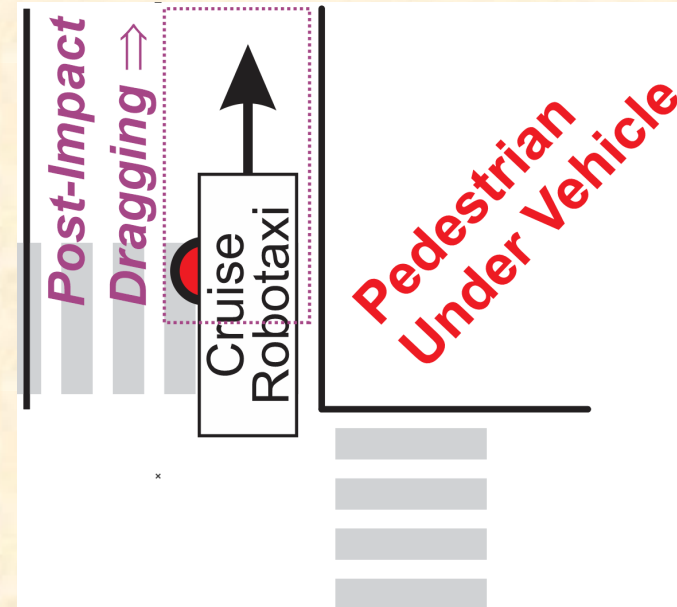
Pedestrian Under Vehicle

■ **Pedestrian under vehicle not sensed**

- However – pedestrian legs were in view of camera throughout dragging
- Vertical motion & wheel slip indicated something under vehicle

■ **Under-vehicle sensors?**

- Might help for other mishaps
- *HOWEVER* – ample sensor data in this crash to detect pedestrian
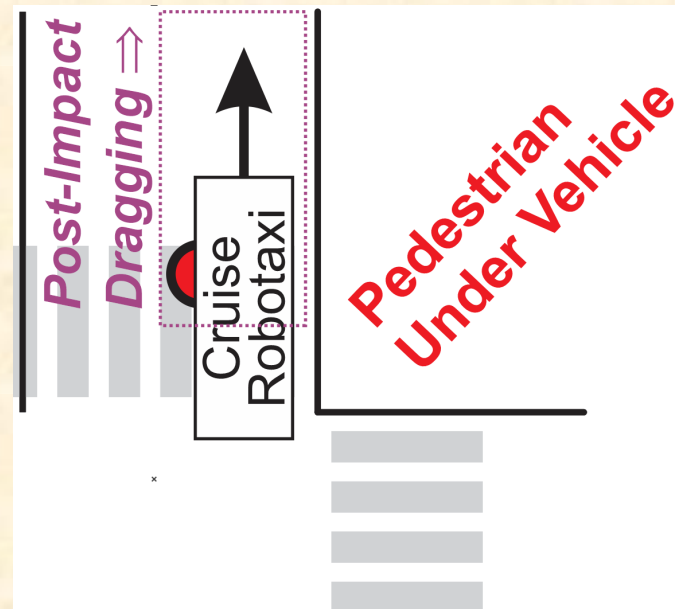
What Went Right After the Mishap?

- **What went right post-crash:**
  - Car opened remote assistance channel
  - Operators were able to see crash video
  - On-scene voice communications worked
  - Engineering crisis team formed quickly

**NHTSA
CA DMV
CPUC
SF City**

- **What went right with regulatory response:**
  - Established & conformed to internal messaging strategy
  - Held immediate meetings with regulatory stakeholders
  - Held some interviews with press

Post-Crash Tactical Issues

- **Failure to call e911**
  - No record of Cruise contacting e911
  - Bystander called emergency services

- **Operations & crisis team coordination**
  - Remote assistance knew of dragging
  - On-scene support suspected dragging
  - Engineering/corporate emergency teams said to not know about dragging for 6+ hours
    - Oct 3 at 3:45 AM group message

Evolving Media Coverage

San Francisco Chronicle

Woman run over by an autonomous vehicle in San Francisco

Oct. 2, 2023 | Updated: Oct. 2, 2023 10:16 p.m.

The Verge

Oct 3, 2023, 9:20 AM EDT

Cruise says a hit-and-run 'launched' pedestrian in front of one of its robotaxis /
The incident is the latest to involve a driverless vehicle in San Francisco, where hundreds of robotaxis are operating commercially 24/7.

https://bit.ly/3yIRIMH

DRIVERLESS CAR RUNS OVER WOMAN AFTER CRASH
SAN FRANCISCO
abc 7

https://bit.ly/4dBQhJu

https://bit.ly/4dh7g3T

San Francisco Chronicle

Driver hits woman in S.F., then Cruise driverless car runs her over; photo shows victim trapped

Oct. 2, 2023 | Updated: Oct. 3, 2023 9:40 a.m.

Includes photo of pedestrian pinned under rear axle.

Controlling The Narrative

- ■ **Cruise focus on controlling narrative**
  - ● **Emphasis on blaming Nissan driver**
  - ● **Withheld dragging from press**
- ■ **"Let the video speak for itself"**
  - ● **Video playback issues**
    - – **Regulators did not notice dragging**
  - ● **Ineffective messaging of bad news**
  - ● **Did not correct too-favorable reporting**
- ■ **Three weeks until dragging disclosed**
  - ● **Initially CA DMV did not realize dragging had happened**
  - ● **CA DMV revoked Cruise permits; dragging sequence made public**

Cruise hid video of woman being dragged along San Francisco street, DMV says

The San Francisco Standard

Published Oct. 24, 2023 • 2:48pm

- ■ **Funding/market pressure to deploy quickly**
  - ● **Aggressive scale-up strategy**
  - ● **Numerous incidents suggest safety drivers were removed prematurely**
    - – Fire truck crash; clogged streets
- ■ **Tactical issues vs. hazard mitigation**
  - ● **Immediate pull-over likely motivated by bad press for clogging roads**
- ■ **Insufficient respect for rare events**
  - ● **Thrown pedestrian called "unrealistic" and "insane hypothetical" after the fact**

San Francisco's fire chief is fed up with robotaxis that mess with her firetrucks. And L.A. is next

https://bit.ly/3Wc3bXA

San Francisco Fire Chief Jeanine Nicholson says state regulators are moving too fast on robotaxi expansion, jeopardizing public safety. Meanwhile, Waymo and Motional are planning to begin robotaxi service in Los Angeles. (Lea Suzuki / San Francisco Chronicle via Associated Press)

High-Level Takeaways

- **Off-nominal "rare" situations matter**
  - Secondary involvement in mishaps
  - Unusual presentations of road users
  - Post-mishap situations are complex
- **Lack of transparency degrades trust**
  - The (alleged) cover-up is always worse
  - Optics & substance of taking safety seriously
    - Cruise did not do a safety stand-down
- **Safety culture matters**
  - Robotaxis need robust operational support
  - Pre$$ure to deploy ➔ pressure on safety culture

Cruise slashes 24% of self-driving car workforce in sweeping layoffs

Cruise, the GM self-driving car subsidiary, is laying off 900 workers to slash costs and revamp the company, TechCrunch exclusively learned

Kirsten Korosec / 7:50 AM PST • December 14, 2023

https://bit.ly/4djcLzc

Cruise resumes supervised autonomous driving with safety drivers

Updated June 11th, 2024
As of 6/11, Cruise has resumed **manual driving** Phoenix, AZ, Houston and Dallas, TX. Supervised driving is underway in Phoenix and Dallas.

https://www.getcruise.com/news/blog/2024/cruise-resumes-supervised-autonomous-driving-with-safety-drivers/