Autonomous Cars
Day 2

Center for Learning in Retirement
Delaware Valley University
October 13, 2026
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Presentation Link: https://seniortechadvisor.com/wp-content/uploads/2026/10/nothing_is_autonomous_presentation.pdf

Format

Day 1 – Electric Cars (October 6)

- We'll focus today's class on "The State of EV Adoption in the US".
- A lot has changed in the last 30 years since GM's EV1 rolled off assembly lines (then disappeared 7 years later). Then Tesla Motors was born, and the rest is history.

Day 2 – Autonomous Cars (Today)

- This session is called "Nothing Is Autonomous".
- What is automation and why is it so hard to achieve? For those who have experienced Tesla's full self-driving capability (FSD), they understand, and there's a reason it's still called FSD "Supervised".

BASED ON BUSINESS INSIDER | THE LIMIT

Nothing Is Autonomous

The hidden humans behind self-driving cars

Based on Business Insider video transcript

The Core Reality

Driverless does not mean humanless

> **"None of these cars are fully autonomous, no matter how good they seem to be at navigating the roads."**

The Promise

Self-driving cars that navigate any road, anytime, without human intervention — a trillion-dollar market waiting to be unlocked.

The Reality

Geofenced areas, remote assistance, depot workers, safety drivers, and humans at every step of the way.

What We'll Cover

A six-part journey through the robotaxi landscape

01 **The Autonomy Illusion**

Why "driverless" still depends on humans

02 **Two Technical Bets**

Waymo's sensor stack vs. Tesla's cameras

03 **Where Autonomy Breaks**

School buses, snow, long-tail edge cases

04 **The Human System**

Remote help, depots, blackouts, the ratio

05 **Trust, Safety & the City**

Backlash, KitKat, Helsinki, resistance

06 **Where Autonomy Wins**

Ports, mines, trucking, the real path

PART 1

The Autonomy Illusion

Why "driverless" still depends on humans

First Ride, First Contradiction

Inside a Waymo on the windiest street in San Francisco

It looks like no one is driving the car. But Waymo only operates in specific geofenced locations. Tesla's Full Self-Driving requires eyes on the road and hands on the wheel. And when any of these cars get stuck, they require human intervention.

The Illusion

No steering wheel movement, no driver in the seat. It feels like the car is doing everything on its own.

The Reality

Geofenced to specific cities. Remote assistance teams on standby. Safety drivers during testing. Humans behind every step.



Driverless Does Not Mean Humanless

The layers of human support behind every robotaxi

Self-driving cars are coming to cities near you. But we still don't know how many humans it takes to drive them. The question isn't whether the car can drive — it's how many people it takes to make it drive.

Remote Assist

Call-center agents who help stuck vehicles navigate difficult situations.

Depot Workers

Clean, charge, maintain, and service the fleet at local facilities.

Safety Drivers

Test drivers who ride along during training, recording data and doing triage.

Waymo vs. Tesla at a Glance

Two companies, two completely different approaches

Waymo

SAE Level 4 (mostly) - No driver in the seat

- Lidar + radar + 29 cameras
- Geofenced to specific cities
- No driver in the seat
- Remote assistance when stuck
- Owned and operated by Waymo

Tesla

SAE Level 2 (driver assist) - Car steers and brakes, but human must pay attention.

- 8 cameras only, no lidar or radar
- Operates anywhere (in theory)
- Driver must pay attention
- Consumer-owned vehicles
- Evades robotaxi regulations


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CHAPTER 1
LIDAR VS. CAMERA-ONLY
BI

The Trillion-Dollar Question

Not "can the car drive?" but "how many humans does it take?"

The market for self-driving technology is estimated at a trillion dollars. But the key question isn't technological — it's economic. How many humans does it take to operate a fleet of "driverless" cars?

If the Ratio Is Low

Few humans per car means the economics could work. The labor cost is spread across many vehicles, and the service becomes profitable at scale.

If the Ratio Is High

If the same number of humans are involved but outside the car instead of inside it, "I don't see how you make this economically viable."

PART 2

Two Technical Bets

Waymo's sensor stack vs. Tesla's camera-only approach

Waymo's Sensor Stack

Lidar, radar, and 29 cameras working together

Waymo's approach is built on redundancy: multiple sensor types cross-check each other. If one sensor fails or is confused, others compensate.

Lidar

Spins laser pulses to build a high-resolution 3D map of nearby cars, cyclists, and pedestrians.

Radar

Uses radio waves to track object speed and distance — even through rain, fog, and dust.

29 Cameras

Read colors, signs, and traffic signals — providing visual context the other sensors can't.

Tesla's Camera-Only Bet

Eight cameras and AI — no lidar, no radar

Elon Musk called lidar "a fool's errand" — expensive and unnecessary. Tesla relies on just eight cameras, barely visible on the vehicle, paired with AI to interpret the road.

The Advantage

Cost. It's far cheaper to navigate with cameras and AI than with a full sensor stack. Every Tesla on the road today could potentially become a robotaxi.

The Concern

Experts say camera-only will never truly be safe. "If you're serious about self-driving, you don't have just a single sensor. Camera-only is like tying one hand behind your back."

The Cost vs. Redundancy Tradeoff

Two philosophies, two different risk profiles

Waymo: Redundancy

Multiple sensor types mean if one fails or is confused, others compensate. Safer in theory — but expensive.

Tesla: Scale

Cameras are cheap. If Tesla can prove its system is safe enough, every Tesla already on the road could become a robotaxi overnight.

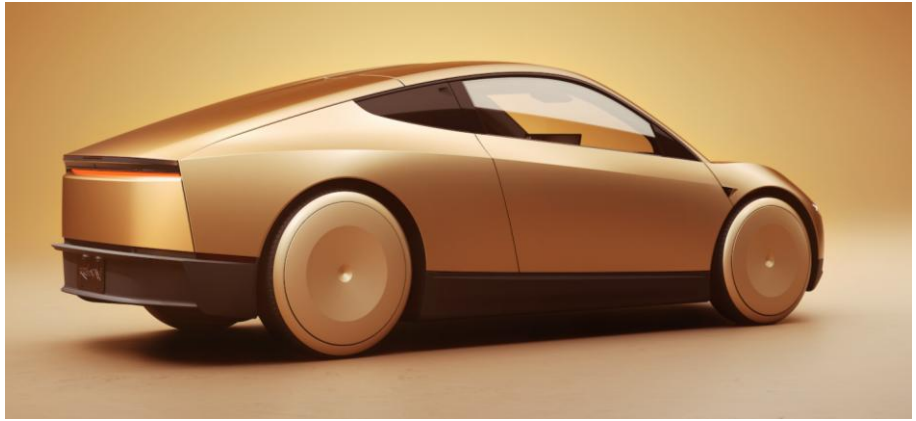
"It will be like an Airbnb thing. You can add your car to the fleet and it makes money for you while you're gone."



The **Jaguar I-PACE** vehicles used by Waymo are retrofitted passenger cars ($150,000 to $175,000)



Hyundai IONIQ 5 is a factory-customized, autonomous-ready platform ($50,000)



Tesla Robotaxi – purpose-built by Tesla (<$30,000)



Why Tesla's Upside Is Enormous

A fleet that already exists

Morgan Stanley analysts expect 1 million cyber cabs on the road by 2035. Their projections show robotaxis taking over a third of all ride-share miles in the years to come.

1M

Cyber cabs by 2035

Morgan Stanley's projection for Tesla's robotaxi fleet.

1/3

Of ride-share miles

Projected share of ride-share miles going to robotaxis.

Existing

Fleet already deployed

Every Tesla on the road today is a potential robotaxi.

PART 3

Where Autonomy Breaks

School buses, snow, and the long tail of edge cases

The School Bus Problem

When robotaxis fail at ordinary driving scenarios

There's a long list of normal driving scenarios that robotaxis struggle with. One of the most alarming: Teslas don't always stop for school buses with their lights flashing.

Dan Odowd's Tests

A critical systems engineer who designed F-35 software has spent millions showing Tesla FSD flaws. The latest version still passes school buses 4 out of 5 times.

Not Just Tesla

Waymo is under investigation in Austin, Texas for passing school buses. In Santa Monica, a Waymo hit a 9-year-old outside a school during dismissal. The child wasn't seriously injured.


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The SAE Levels of Automation

Six levels from no automation to full autonomy

Level 0 No Automation

The car does everything. Most cars on the road today.

Level 1 Assisted

Car can steer or brake, but not both. Like lane assist.

Level 2 Partial Automation

Car steers and brakes, but human must pay attention. **Tesla** FSD is here.

Level 3 Conditional

Automated until it calls for human help. The handoff problem.

Level 4 High Automation

No driver in the seat. Waymo is here — mostly. Gets stuck sometimes.

Level 5 Full Automation

Drives anywhere, anytime, any conditions. The holy grail. Doesn't exist yet (ever?).

The Handoff Problem

Level 3's dangerous middle ground

Level 3 is automated until suddenly it calls for human assistance — and you need to step in right away. The transition from not-driving to driving is the most dangerous moment*.

Why Tesla Stays at Level 2

By keeping FSD at Level 2, Tesla evades all robotaxi regulations — which only apply at Level 3 and above. The driver is legally responsible.

Why Waymo Is "Mostly" Level 4

Waymo is Level 4 most of the time — but when they get stuck, they "phone a friend." That remote helper makes them partially a driver.

The OOTL Problem – the **out-of-the-loop performance problem arises when an operator suffers from performance decrement as a consequence of automation.*

Snow as a Sensor Problem

When the road disappears

For cameras and sensors, snow is especially problematic. It can erase lane lines and make everything look like a blank white sheet. Snowflakes create noise inside lidar and radar sensors and block cameras.

Waymo's Winter Push

Driving year-round in 10 snowy states. Sensor-cleaning technology on Jaguar I-Pace. The new Zeekr model will have improved cleaning for heavier weather.

The Training Gap

Waymo admits winter weather is underrepresented in their training models. They've added simulated snow scenarios to compensate — but simulations have limits.


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MY LOCATION
Sheepshead Bay
19° | Feels Like: 2°
SEVERE WEATHER
Heavy Snow Forecasted
HOURLY FORECAST
PRECIPITATION
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Simulation Helps — Until It Doesn't

The "moose problem" and the limits of modeled reality

Waymo's "world model" can transform scenarios — turning a dry condition into a snowy one to multiply training data. But the catch: if the simulation doesn't have something in it, you'll never train against it.

The Moose Problem

If your simulation has no moose, the first time you see one, you have an edge case you're not trained for. Simulations help but don't fully solve the problem.

The Demos

Waymo's website shows simulations of driving into a tornado and handling a charging elephant. Impressive — but those are the cases they thought to include.


Washington, D.C.
18/25 mph
AUTO
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The Long-Tail Problem

Rare events that are consequential

Real edge cases that actually happened: wet cement on the road, a car hauling a swaying tree, and a man in a wheelchair chasing a duck across the road. These are the scenarios that break autonomous systems.

Wet Cement

A road surface that looks normal but isn't — the car can't distinguish it from regular pavement.

Swaying Tree

A truck hauling a tree that sways in the wind — unpredictable motion the system must interpret.

Wheelchair + Duck

A man in a wheelchair chasing a duck across the road — a scenario no training data covers.

What is the ‘Long-Tail’ Problem?

The **long-tail problem** in autonomous vehicles refers to the immense challenge of handling rare, unpredictable, and edge-case scenarios—the "tail" of the probability distribution of everyday driving conditions.
The "**head**" of the distribution includes lane keeping, highway cruising, and stopping at red lights, etc.

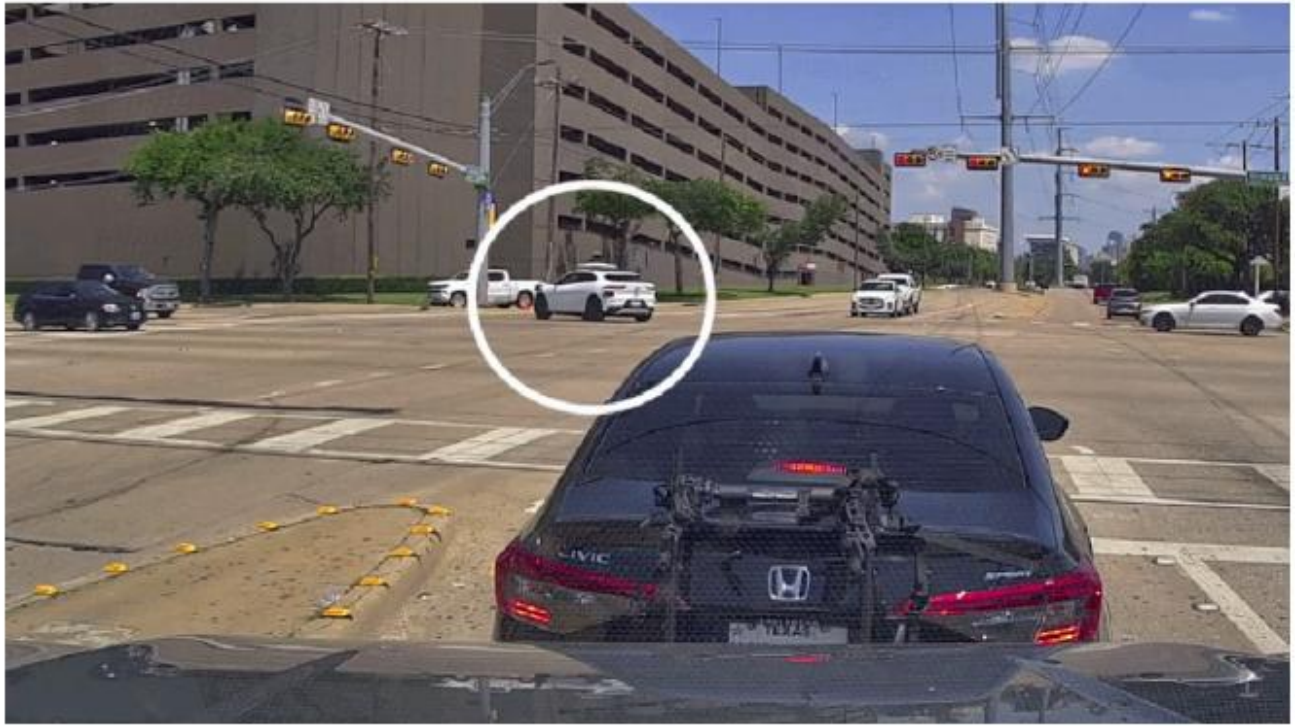
Key Aspects of the Long-Tail Problem

- Extreme Rarity of Edge Cases
- The Exponential Effort Dilemma
- Safety & Predictability Risk
- Continuous Edge Case Discovery

How Developers Are Addressing It

- Massive Fleet Data Collection
- Synthetic Data & Simulation
- Generative World Models & End-to-End AI

Waymo Robotaxi Runs Red Light



Billions or Trillions of Miles

Why proving safety requires massive scale

Before they can truly say these cars are safer than human drivers, robotaxis should expect to clock billions or maybe trillions of miles — so they can encounter as many edge cases as possible.

The 99% Problem

"We're done with the first 99%, but we still have another 99% to go." The gap between hundreds of robotaxis and millions is dramatic.

The Human Benchmark

Humans drive trillions of miles per year. 40,000+ deaths. It's a numbers game. But there's no computing power that can predict how the public will react when something goes wrong.

PART 4

The Human System Behind the Car

Remote help, depots, blackouts, and the human-to-car ratio

Remote Assistance Is Part of the Product

Waymo's "phone a friend" model

When a Waymo gets stuck, it calls a remote assistance center. Waymo has around 70 remote agents on duty at any time. About half of them are overseas — in the Philippines.

The Congressional Reaction

When Congress learned remote agents were in the Philippines, one representative responded: "That is completely unacceptable." Jurisdiction and accountability concerns.

The Core Question

"How autonomous are your autonomous cars if you constantly need a human holding its hand?" — Lloyd Lee, Business Insider


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Waymo's Remote Assistance Centers—often called "Fleet Response" hubs—resemble an advanced, tech-focused operations floor or a modern air traffic control room.





A Stuck Waymo Story

When the system fails and humans can't fix it remotely

A reporter tried to pick up a colleague in an area with terrible cell service. The Waymo passed the house, and the app stopped working. No way to redirect the car. A 30-minute ordeal with remote assistance — and they couldn't fix it.

The Failure Point

The car needed cell service to function. Without it, the app failed, remote assistance couldn't resolve the issue, and the rider was stranded.

The Resolution

A coworker with cell reception had to order a new robotaxi. The humans — not the technology — saved the day. The system couldn't recover itself.

The Blackout Stress Test

December 2025: when 800+ Waymos lost power

A major blackout in San Francisco showed how fragile current AV systems are. More than 800 Waymo vehicles were in the outage area and experienced over 1,500 stoppages.

800+

Waymos affected

Vehicles in the blackout area that experienced stoppages.

1,500+

Stoppages total

Individual incidents of vehicles stopping during the outage.

96%

Auto-resolved

Resolved autonomously. The remaining vehicles blocked intersections and hindered first responders.


Waymo vehicles block intersection during power outage in San Francisco
0:00
0:37
15
15
CC

Inside the Waymo Depot

The human workforce behind the fleet

At Waymo's San Francisco depot, 60-100 people work in yellow vests servicing vehicles. Charging stations, cleaning supplies, vacuum cleaners, towels organized by day of the week. Colored lights indicate what each vehicle needs.

Charging

Vehicles come in for battery charging between rides. A constant rotation through the depot.

Cleaning

Interior cleaning — vacuuming, wiping, handling biological incidents and lost items.

Maintenance

Colored service lights tell workers what each vehicle needs. A chart-based workflow system.



Waymo Operates 800+ Vehicles in the San Francisco Bay Area

Example of one of four Waymo depots in San Francisco

Training Still Needs Humans

Safety drivers, triage, and the seat that shakes you awake

Waymo employs "drivers" who sit in the driver's seat and either drive manually — with everything recorded for training data — or ride in autonomous mode and do "triage" using steering wheel buttons to send data to developers.

The Dozing Driver

During long autonomous stretches, drivers drift off. The front seat detects this and buzzes or shakes them awake. Even the human monitors need monitoring.

Humans at Every Step

Driving to train them. Tagging data on the back end. Cleaning and servicing. Handling remote calls. Getting shaken awake. The system is deeply human!

PART 5

Trust, Safety, and the City

When one incident becomes a movement

KitKat and the Cost of One Incident

A bodega cat, a Waymo, and a public-trust crisis



KitKat was the beloved bodega cat at Randa's Market on 16th Street in San Francisco's Mission District — known as the "mayor of 16th Street." At 11:30 PM, a Waymo pulled away and killed KitKat after the cat darted under the car.

Why It Mattered

A human driver might have seen the woman searching under the car and investigated before pulling away. The robot didn't understand the context.

The Aftermath

Protests. A media conference with elected officials. A shrine. Merchandise. "Every time I see a Waymo, I spit on it." A single beloved animal can derail public trust.

Cruise and the Fleet-Killing Crash

How one severe incident ended a multibillion-dollar operation

Cruise, operated by GM, suspended San Francisco operations in 2023 after one of its cars dragged a woman underneath it. She was seriously injured. It was the death knell for the service in the city.

The Robotaxi Graveyard

Cruise vehicles now sit in a parking lot gathering dust and grime. The cars that were supposed to revolutionize transportation are literally parked and abandoned.

The Lesson

A single accident can bring down a multibillion-dollar fleet. The technology doesn't have to be perfect — but the public's tolerance for failure is near zero.

Safety Statistics vs. Public Judgment

People judge robotaxis incident by incident

According to studies by the Insurance Institute for Highway Safety (IIHS), Waymo's autonomous vehicles show a 68% lower overall crash rate per vehicle mile traveled compared to human drivers and an 82% reduction in injury-causing crashes.

The Statistics Argument

40,000+ deaths per year on American roads. Robotaxis never drive tired or drunk. In early 2025, Waymo reported zero at-fault injury crashes across 7 million driverless miles.

The Public Judgment

"If you're selling on perfection, every picture makes you look bad." Every viral video, every weird maneuver costs more than any safety statistic can buy back.

Resistance on the Street

Traffic cones, Safe Street Rebel, and public backlash

In 2023, activists calling themselves Safe Street Rebel discovered that placing an orange traffic cone on a Waymo's hood stops it dead in its tracks. A peaceful protest showing the technology isn't as good as it seems.

The Protest Logic

"We were showing through a passive, peaceful object that this technology is not as good as it seems. We never destroyed a car. We were never vandals."

The Broader Frustration

People are fed up with big tech. "To see all the times Waymo has messed up, we have to ask: who's being prioritized? The driverless car companies or the people?"


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Helsinki's Answer

Zero traffic deaths — without self-driving cars

Helsinki, Finland announced zero traffic deaths. They didn't use self-driving cars or wait for AI. They slowed cars down, narrowed roads, planted trees, invested in transit, cycling, and walkable streets.

The Speed Math

Drop a car's impact speed from 40 km/h to 30 km/h, and the risk of killing a pedestrian is cut in half. Slower cars means fewer deaths — the data backs it up.

The Different Question

"What if we just stop designing cities that let cars kill people in the first place?" Autonomy may not be the best or fastest answer to road safety.


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PART 6

Where Autonomy Wins First

The path from partial autonomy to scalable business

Where Full Autonomy Happens First

Ports, mines, and trucking — controlled environments

True Level 5 autonomy is most likely to succeed first in controlled industrial environments — not on city streets. Dull, dirty, dangerous settings where the environment can be managed.

Ports

Oakland's port: constant truck traffic, slow movement, predictable patterns. The dream: trucks that move themselves into loading zones.

Oil Fields

Kodiak runs truly driverless trucks in the Permian Basin — no observer, no remote monitoring. Fully autonomous deliveries across multi-hour routes.

Mines

Rio Tinto: 15+ years of autonomous trucks. One person operates up to 20 trucks. 600 people control operations 1,500 km away from a central control room.

Someone Is Still Behind the Wheel

Robotaxis will continue to be a mix of impressive, frustrating, and potentially dangerous.

The credible pitch isn't perfection — it's "fewest mistakes, transparency, always improving."

Full autonomy arrives first where the world is controlled — not where city streets are messy.

Many companies have tried and failed: Argo AI, Apple, Lyft, and Uber all sold or scrapped their programs. New entrants — Zoox, Tesla cyber cabs, Lucid, Nvidia — are entering. This is a multi-decade slog, and there's another decade or two to go.

"Whenever you see a self-driving car on the road, know that right now someone somewhere is behind the wheel."

You might also be interested in:
How Self-Driving Cars will Destroy Cities (and what to do about it)

Based on provided video transcript

