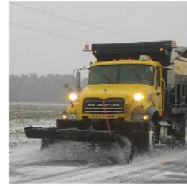


## NORTH CAROLINA

Department of Transportation



# Looking Ahead to Automated Vehicles

Joe Hummer, PhD, PE, State Traffic Management Engineer

For NCLUG Meeting, Raleigh, July 26, 2019

# Disclaimer

- Most of this presentation is my personal opinion, not NCDOT policy or NC law
  - I will try to indicate when something is law or policy
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# Objectives

- How will AVs affect NC?
- What can we do to prepare?
  - Maximize positive benefits
  - Mitigate negative effects

Audi AV, from  
wired.com



# Definition

- Self-driving on-road motor vehicle
- No steering wheel or pedals
  - “Level 5”
- Someone tells the vehicle the destination, vehicle gets there
- Do not need special infrastructure
- Can run empty
  - Or carry only cargo



Automated vehicle developed for Fort Bragg, 2017

# AVs Will Be Adopted Quickly

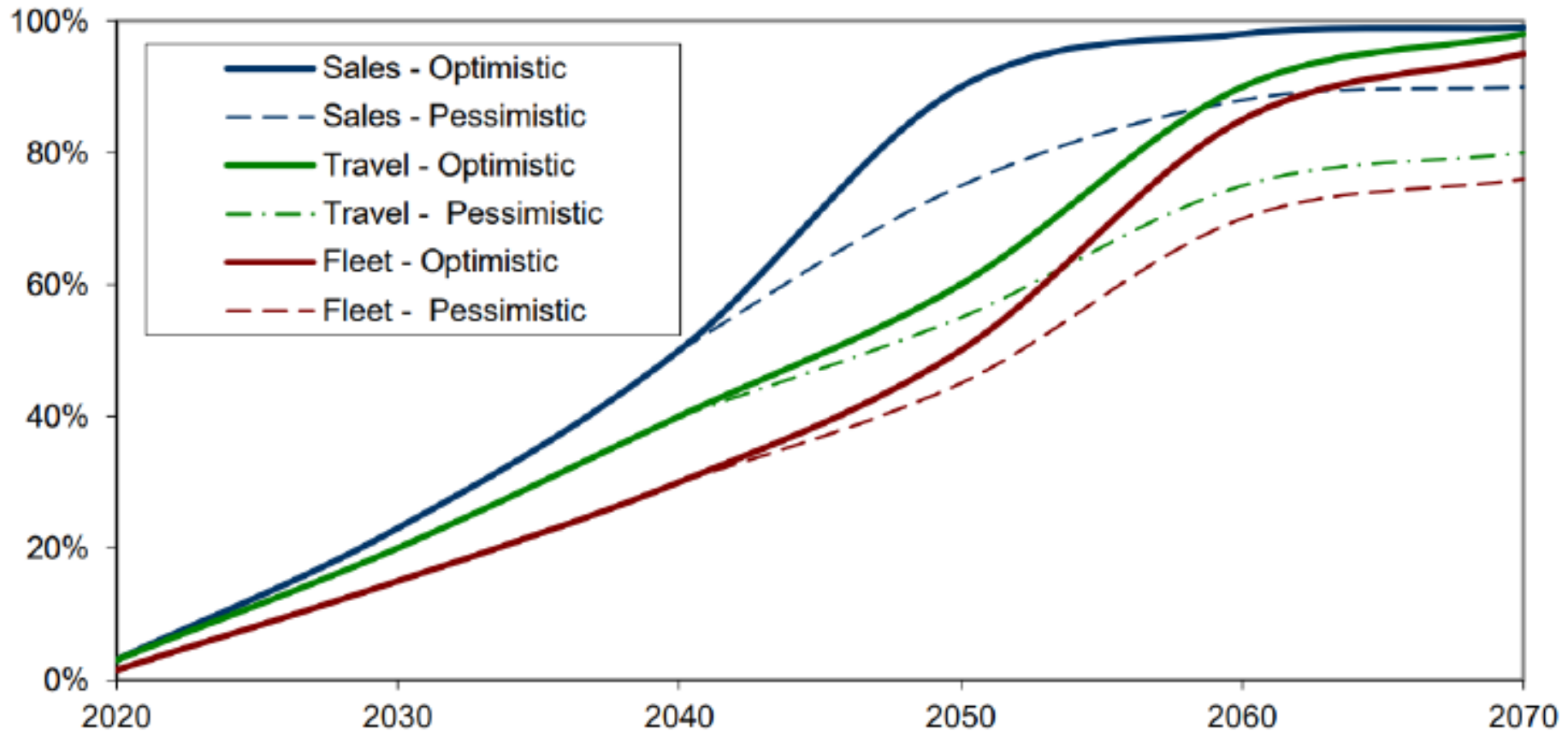
- Safer
- Cheaper
  - Human driving will get more expensive
- Time savings
- Benefits for many groups of consumers
- Manufacturers plan to sell level 5 by 2021
  - Huge R&D expenditures
  - Push by foreign companies
  - Disincentives at levels 3 and 4
- Little new infrastructure needed
- No show-stoppers

# Recent Technologies are Adopted More Quickly

Technology	Percent of US households adopting:	10	20	30	40	50	60	70	80	90	100
	Year introduced	Number of years from introduction until percentage reached									
Stove	1883	18	36	42	51	55	62	65	69	72	101
Telephone	1898	5	10	17	44	48	50	56	64	77	
Electricity	1902	8	13	17	19	22	24	33	39	46	58
Auto	1905	11	13	16	18	42	45	50	65	83	
Radio	1922	3	5	6	7	9	10	13	16	24	
Refrigerator	1925	5	9	12	14	17	21	22	24	27	47
Clothes washer	1925	5	26	30	34	39	45	61	76		
Air conditioner	1948	8	18	20	22	25	35	46	53		
Dishwasher	1949	14	19	22	37	48	53				
Clothes dryer	1949	5	11	16	20	22	33	42			
Color TV	1960	5	7	9	11	12	13	16	20	25	
Microwave	1972	7	11	12	13	14	15	16	19	33	
VCR	1978	5	6	7	8	9	10	13	18		
Computer	1980	5	11	14	16	17	18	21			
Cell phone	1985	8	10	12	13	14	15	17	18		
Internet	1991	2	6	7	8	9	13				
Average		7	13	16	21	25	29	34	40	48	69
Average for technology introduced before 1950		8	16	20	27	33	38	43	51	55	69
Average for technology introduced after 1950		5	9	10	12	13	14	17	19	29	

From Thompson, D., "The 100-Year March of Technology in 1 Graph" The Atlantic, April 7, 2012.

# Recent AV US Adoption Forecast



From Litman, et al., 2018

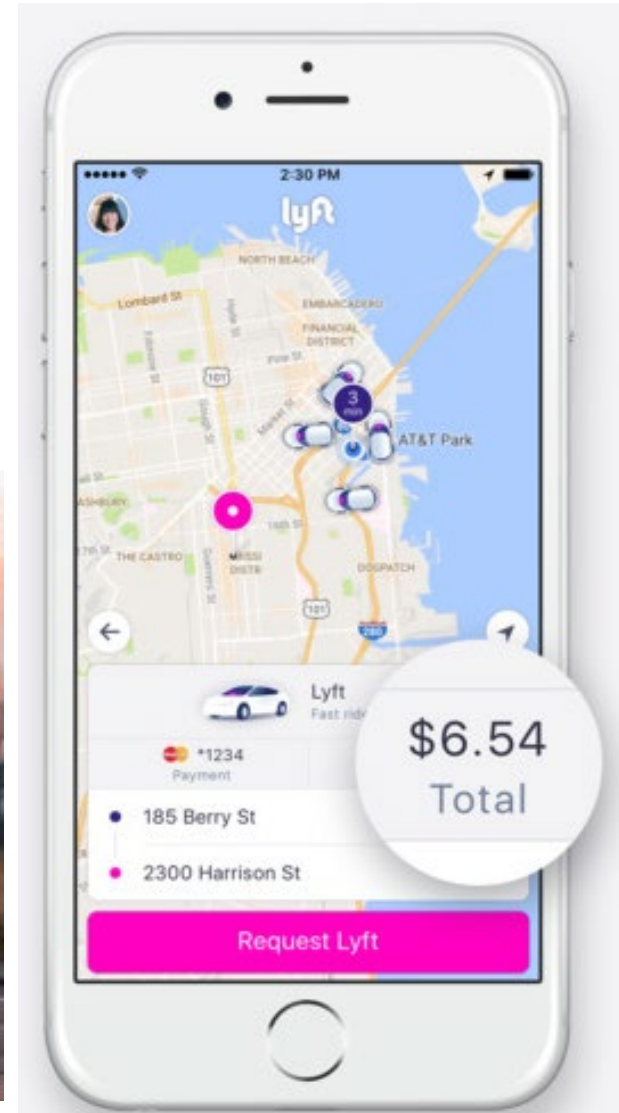
# Changing How We Use Autos

- Automated
- Subscription
- Electric

Source: iTunes



Google "Gumdrop"  
vehicle, from CNET





# As Big a Change As...

- Jet airplane?
- Interstate system?
- Model T?
- Railroads?
- Steamships?



# Safety

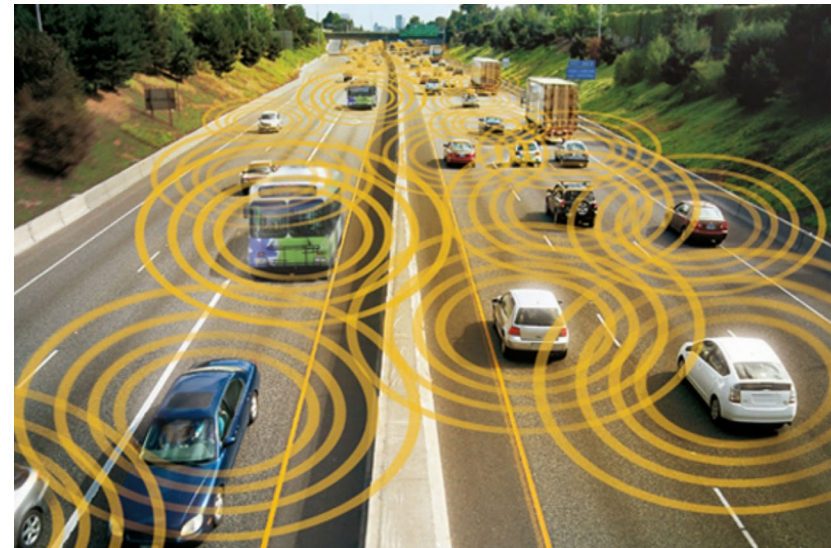
- Currently so awful
  - 38,000 deaths per year in US and climbing
  - 1.2 million deaths per year worldwide
  - “Young person’s disease”
- At least 90 percent of current crashes have human error as major contributing factor
- Widespread adoption of AVs will cut crashes, injuries, and fatalities dramatically

# Safety

- Car sensors are better than human senses
  - More sensors, connected vehicles, ...
- Machine processing times getting faster
- Software updates correct previous errors
  - Human drivers never learn
- Logic always favors safety
- Car companies assume liability, have every incentive to reduce crashes

# Travel Efficiency

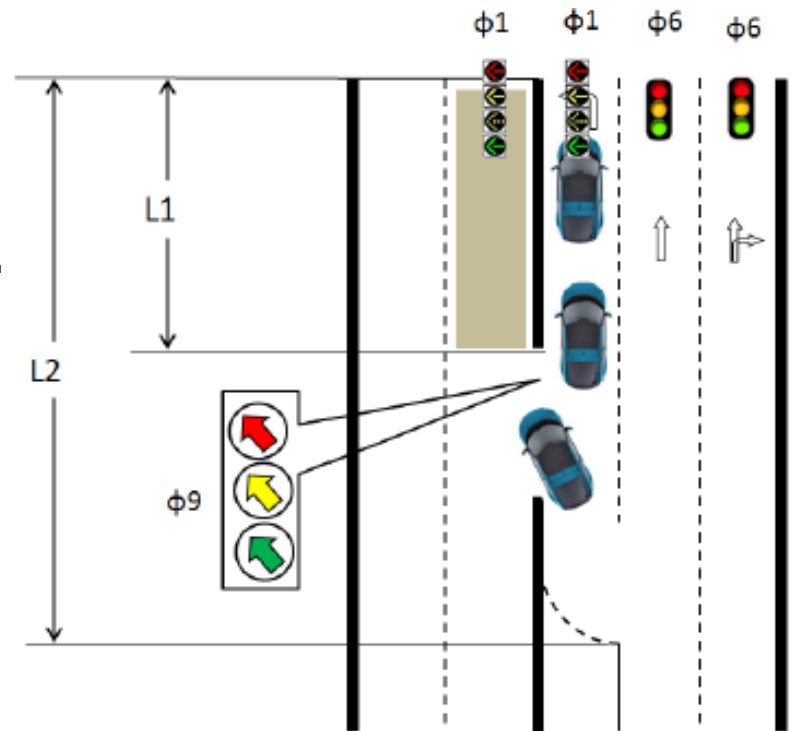
- With all AVs, road capacity increases by up to 50 percent
  - With some human-driven vehicles, benefits will be smaller
- Optimum routing
- More ride-sharing
  - Discount subscriptions
- More trucks at night
- No cruising for parking



Source: CLEPA.edu

# Travel Efficiency

- Narrower lanes
- Cycle-by-cycle or second-by-second lane-use controls
  - Virtual roundabouts, superstreets, road diets, turn prohibitions, etc.



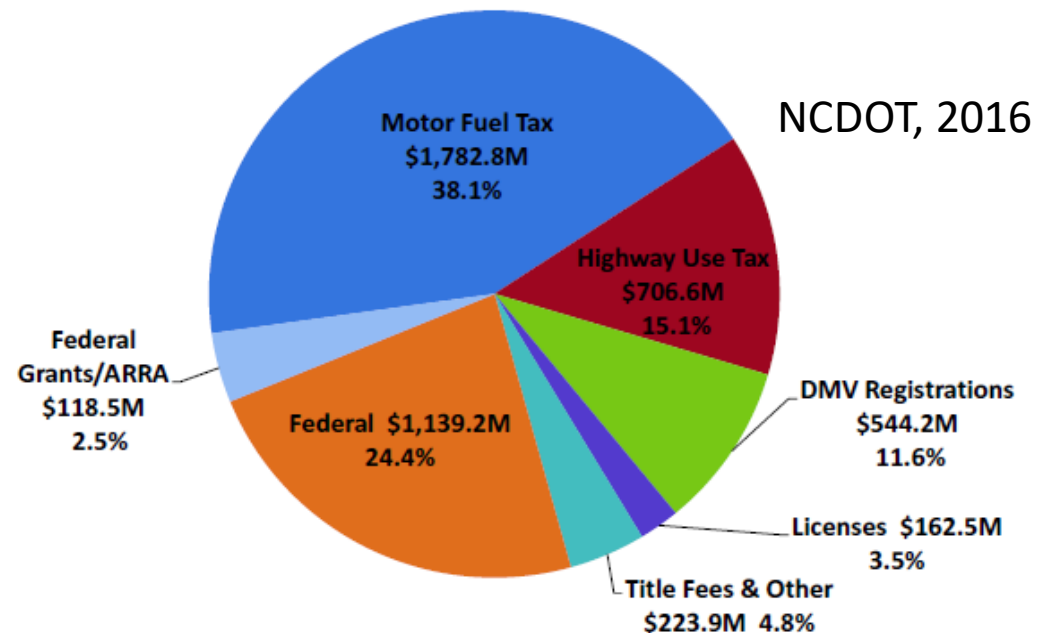
# Travel Efficiency

- On the other hand, auto travel is cheaper and easier, so
  - Empty vehicles
  - More trips
  - Longer trips
  - Mode shift from transit
  
- Overall, likely less congestion



# Roads

- Funding is the big problem
- If no new capacity needed, jobs are another problem
  - Two million highway construction jobs nationwide



# Transit

- Outside of a few big cities, AVs will likely take over much of the transit market
  - Some gain from driverless transit vehicles, but...
  - Door-to-door service
  - More reliable
  - Cheaper for many fare-paying customers
  - Cheaper for taxpayers
  - Local governments can subsidize rides for low-income citizens



# Trucking

- Going driverless is the big cost savings
  - About 1.8 million jobs across the US
- Experiments underway
  - Platooning trucks
  - Beer truck drives across Colorado
- Long-haul terminal to terminal seems easiest

# Older People



Source: Slate.com

# Younger People

- NC law allows 12 year old to be in AV alone



Source: Twitter.com

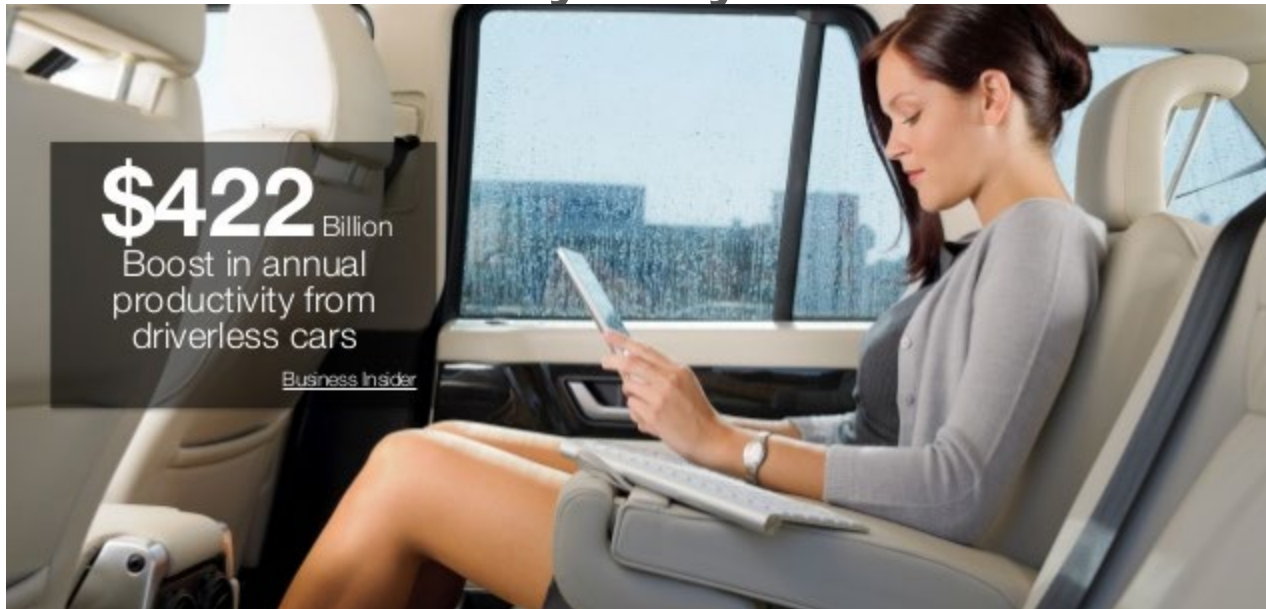
# Disabled People



Source: Jalopnik.com

# Commuters

- And millions of Americans who travel as part of their jobs every day
- What will you do with your extra free time in the car every day?



Source: Slide Share

# Land Use Changes

- Parking
- Denser downtowns



# Land Use Changes

- Retail



# Land Use Changes

- Housing





# Land Use Changes

- Exurban Areas



# Environmental Impacts

- Air
  - CO<sub>2</sub>
- Water
- Noise
- Wildlife
  - Car-kill
  - Habitat
- Oil industry
  - Gas stations



Deepwater Horizon explosion.  
Source: Slate.com

# Other Impacts

- Tourism
- Auto business
- Utilities
- Law enforcement
- Health care
- Evacuations
- Schools
- Others?



*Hurricane Rita Evacuation  
September 17, 2005*

Source: Houston Public Media

# NCDOT Encourages Automated Vehicle Adoption

- SAFETY!
  - Reduce the 1,500 fatal victims per year
  - Reduce the 125,000 injury victims per year
  - Reduce the billions in economic damage
- Mobility for more citizens
- Reduce or eliminate congestion
  - Greater access to jobs
  - Faster goods movement

# NCDOT and NC Government Will Play a Big Role in AV Adoption

- We build and operate roadways
- We license drivers
- We register vehicles
- We establish and enforce driving and vehicle laws and ordinances
- Tort cases are heard in our courts



# 2017 Legislation

- HB 469 defined fully automated vehicles, made them legal, and formed DOT committee
  - Passed Senate 45-2, House 114-1
- HB 716 made truck platooning legal where allowed by DOT ordinance
  - Passed Senate 45-1, House 117-0

# Down the Line for DOT

- Laws and institutions in place
- Stable and reliable funding source
- Smooth pavements
- Good quality pavement markings
- Advanced traffic engineering
- Good communication between state agencies and vehicle companies



# A Hopeful Future

- With AVs, travel could be
  - Much safer
  - Cheaper
  - Quicker
  - Available for more people
  - Less stressful
  - Better for the environment
  - Better for business
  - Creating more jobs





# Needed Actions

- Federal legislation
  - Vehicles
- State legislation, courts
- Local governments
  - Parking, land uses
- Public and media do not panic
- Train people for new businesses
  - Battery techs, not truck drivers
- Research

# Thank You!

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