Prof. Philip Koopman
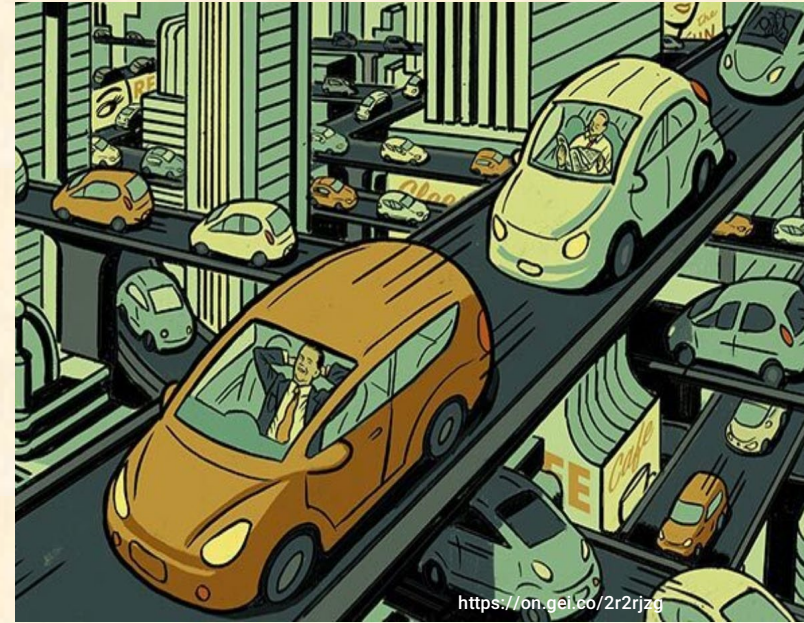
Overview of Automated Vehicle Terminology & J3016 Levels

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Overview

- **Guide to SAE J3016 terminology**
  - **The good**
  - **The bad**
  - **The ugly**
  - *SAE J3016 is not a safety standard*

- **The SAE Levels Explained**
  - **Perhaps not what you thought**
  - **Debunking some myths**

- **A different way to look at automation modes**

https://on.gel.co/2r2rjzg

Basic SAE J3016 Terminology

- **ODD: Operational Design Domain**
  - Environment system is designed to work within
- **OEDR: Object and Event Detection and Response**
  - Monitoring & responding to driving environment
- **DDT: Dynamic Driving Task**
  - Driving vehicle, performing OEDR, avoiding crashes
- **ADS: Automated Driving System**
  - Computer system that can completely perform driving (DDT)
- **Fallback:**
  - Operating vehicle when something goes wrong (e.g., ADS failure)
- **MRC: Minimal Risk Condition**
  - Bringing vehicle to stop as part of fallback operation

SAE J3016 Levels

Level	J3016 Name	Steering & Speed	OEDR	DDT Failures	Vehicle Failures	Perform Fallback	ODD Scope	Other Safety
0	No Driving Automation	Driver	Driver	Driver	Driver	Driver	n/a	Driver
1	Driver Assistance	Split	Driver	Driver	Driver	Driver	Limited	Driver
2	Partial Driving Automation	Auto-mated	Driver	Driver	Driver	Driver	Limited	Driver
3	Conditional Driving Automation	ADS	ADS	ADS	Driver	Driver	Limited	Driver
4	High Driving Automation	ADS	ADS	ADS	ADS	ADS	Limited	Driver
5	Full Driving Automation	ADS	ADS	ADS	ADS	ADS	Unlimited	Driver

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Other J3016 Terminology Notes

- **Automated vs. Autonomous**
  - J3016: always uses "automated" with regard to ADS
  - ANSI/UL 4600: uses "autonomous" for whole vehicle, not just ADS
- **Autopilot:**
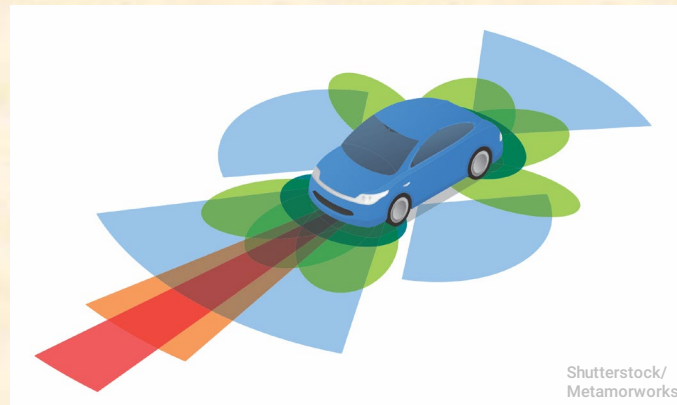 - J3016: neither defined nor used
- **Robotic, Robotaxi:**
  - J3016: do not use term
- **Driverless vehicle**
  - J3016: do not use term, although "driverless operation" is OK
- **Self-driving**
  - J3016: do not use term

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Operating Mode	Human Role	Driving	Driving Safety	Other Safety
Assistive	Driving	🧍	🧍	🧍
Supervised	Eyes ON the road	🚗	🧍	🧍
Automated	Eyes OFF the road	🚗	🚗	🧍
Autonomous	No human driver	🚗	🚗	🚗

Vehicle Automation Modes

https://bit.ly/3r1dhKE

Driver Roles Contrasted

- **Assistive & Supervised**
  - Driver attention required
    - Vehicle responds to driver
  - Potential blame on automation for unsafe intervention
    - Incentivized to be conservative
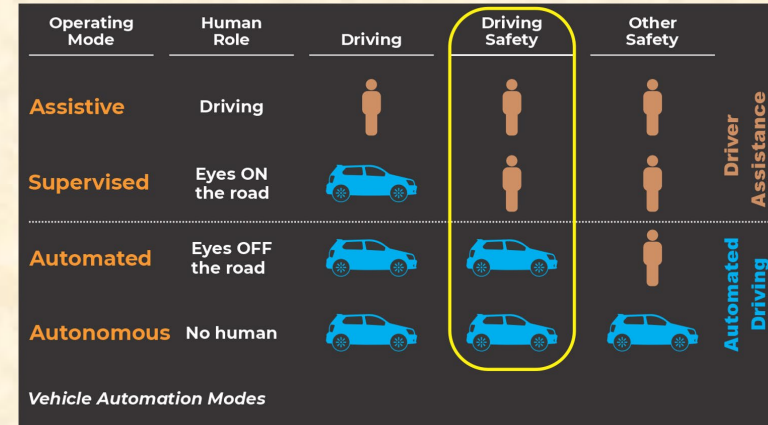
- **Automated & Autonomous**
  - No human attention on driving
    - Vehicle cannot count on human intervention for driving safety
  - ADS potentially at fault for crashes, not human driver

Operating Mode	Human Role	Driving	Driving Safety	Other Safety	
Assistive	Driving	🧍	🧍	🧍	Driver Assistance
Supervised	Eyes ON the road	🚗	🧍	🧍	
Automated	Eyes OFF the road	🚗	🚗	🧍	Automated Driving
Autonomous	No human	🚗	🚗	🚗	

Vehicle Automation Modes

https://bit.ly/3r1dhKE

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Interpreting Vehicle Feature Names

- **"Autopilot" systems: lane keeping + adaptive cruise control**
  - Tesla "Autopilot" → SAE Level 2 / Supervised
  - Tesla "Full Self Driving" → SAE Level 2 / Supervised
  - Porsche Taycan → SAE Level 2 / Supervised
  - Cadillac "Super Cruise" → SAE Level 2 / Supervised
  - … others …
- **Low Speed Automatic Lane Keeping System**
  - UN Regulation No. 157 ALKS; traffic jam pilot under 60 km/hr
  - Announced but not confirmed deployments → Perhaps SAE Level 3
    - Either Supervised or Automated depending on driver responsibility
- **No constant human supervision**
  - Waymo Robotaxi → Perhaps SAE Level 4 / Autonomous

Top SAE J3016 Myths – 1

- **Myth: ODD means Geo-Fencing**
  - Other factors: lighting, weather, infrastructure failures, …

- **Myth: Higher SAE J3016 Levels are necessarily safer**
  - Not a safety standard!   SAE Level 2 & 3 are problematic as defined
    - E.g., no requirement for driver monitoring
  - Higher levels introduce more automation, but not necessarily safety
  - "Level 2+" is meaningless

- **Myth: Driver backs up ADS object detection in Level 3**
  - Level 3 by definition handles 100% of OEDR
  - If driver can be blamed for not intervening while driving, that is Level 2

https://users.ece.cmu.edu/~koopman/j3016/

- **Myth: Level 3 always provides 10 seconds to take over**
  - "at least several seconds" … no requirement that driver is ready
  - No warning time for "evident" vehicle failure
  - No requirement to maintain safety if driver does not take over
    - ADS that can always perform fallback is Level 4

- **Myth: Level 3 means "eyes off road"**
  - ADS does whole DDT, but driver needs situational awareness
    - Example: ADS not required to handle tire blow-out
  - "Eyes off road" is in published graphics, but not in the standard

https://users.ece.cmu.edu/~koopman/j3016/

Other Top AV Myths

- ■ **Myth: "94% of crashes are driver error"**
  - ● Not what the US DOT study actually says.
  - ● Humans played *some* role in 94% of crashes
    - – Yes, drunk driving
    - – Yes, other human frailties
    - – <u>But</u> also some things that AVs will struggle with
      - » "Recognition" and "Decision" errors

- ■ **Myth: "AVs don't drive drunk, so they will be safer"**
  - ● AVs lack common sense; will make <u>*different*</u> mistakes
  - ● Insufficient data to know how this will turn out
    - – Existing Level 2 data is human+machine safety, not autonomy safety

NHTSA

Benefits of Automation

SAFETY

The safety benefits of automated vehicles are paramount. Automated vehicles' potential to save lives and reduce injuries is rooted in one critical and tragic fact: 94 percent of serious crashes are due to human error. Automated vehicles have the potential to remove human error from the crash equation, which will help protect drivers and passengers, as well as bicyclists and pedestrians. When you consider more than 35,092 people died in motor vehicle-related crashes in the U.S. in 2015, you begin to grasp the lifesaving benefits of driver assistance technologies.

https://www.nhtsa.gov /technology-innovation/automated-vehicles-safety

Summary

- **SAE J3016 is a terminology standards document**
  - Not a safety standard
  - Defines levels that may not match what is actually built
  - Plenty of misleading and incorrect information circulating
  - Summary here: https://users.ece.cmu.edu/~koopman/j3016/

- **Real vehicles might not exactly match Levels**
  - Regulating or legislating using Levels is a bad idea
  - Instead, concentrate on driver role & responsibility
    - Clear statement of driver responsibility
    - Don't let people get used as a moral crumple zone

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