How Many Operational Design Domains, Objects and Events?

SafeAI, January 27, 2019

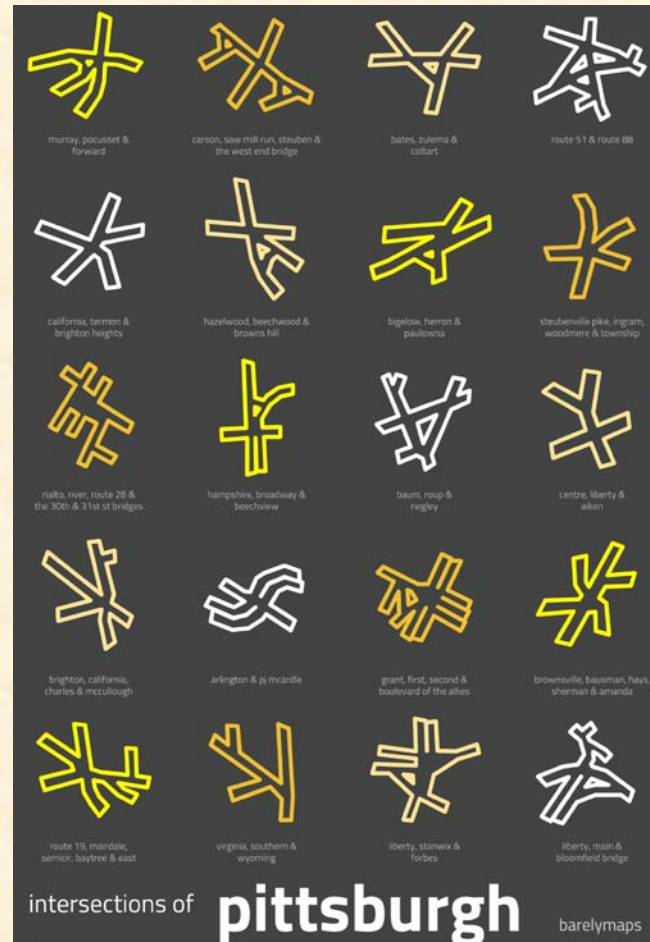**Prof. Philip Koopman**

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@PhilKoopman

Introduction & Terminology

- **Operational Design Domain (ODD)**
  - Environment in which the vehicle operates

- **Object and Event Detection and Response (OEDR)**
  - Things that happen
  - Obstacles and roadways

- **Maneuvers**
  - Things the vehicle does
  - Turns, enter/exit traffic streams, …

- **Fault management**
  - How faults are mitigated

[General Motors]

Won't Geo-Fencing Solve This?

PITTSBURGH, PA

[Google Maps] – approximately 6 miles wide x 4.5 miles high

https://www.etsy.com/shop/BarelyMaps

intersections of **pittsburgh**

barelymaps

What Is Following Distance In Snow?

- **Canton Ave., the steepest street in the world***
  - Half concrete, half cobblestone
  - Cars slide backwards down hill in snow

(*) Guiness Book lists Baldwin Street in New Zealand as steepest, with 35% grade, but Canton Ave has 37% grade for 6.5m

[https://en.wikipedia.org/wiki/Canton_Avenue]

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Have You Trained on All Street Signs?

- **STOP: Except Right Turn.   Wait… where's the turn?**

[Google Street View]

Why Did the Pedestrian Not Cross the Street?

- **Classification:**
  - Is this a person?
  - Is King Friday a baby?
- **Behavior prediction:**
  - Is it about to cross the street?

- **Fredosaurus Rex Friday XIII**
  - Mr. Rogers fans entry for Pittsburgh Dinosaur Parade

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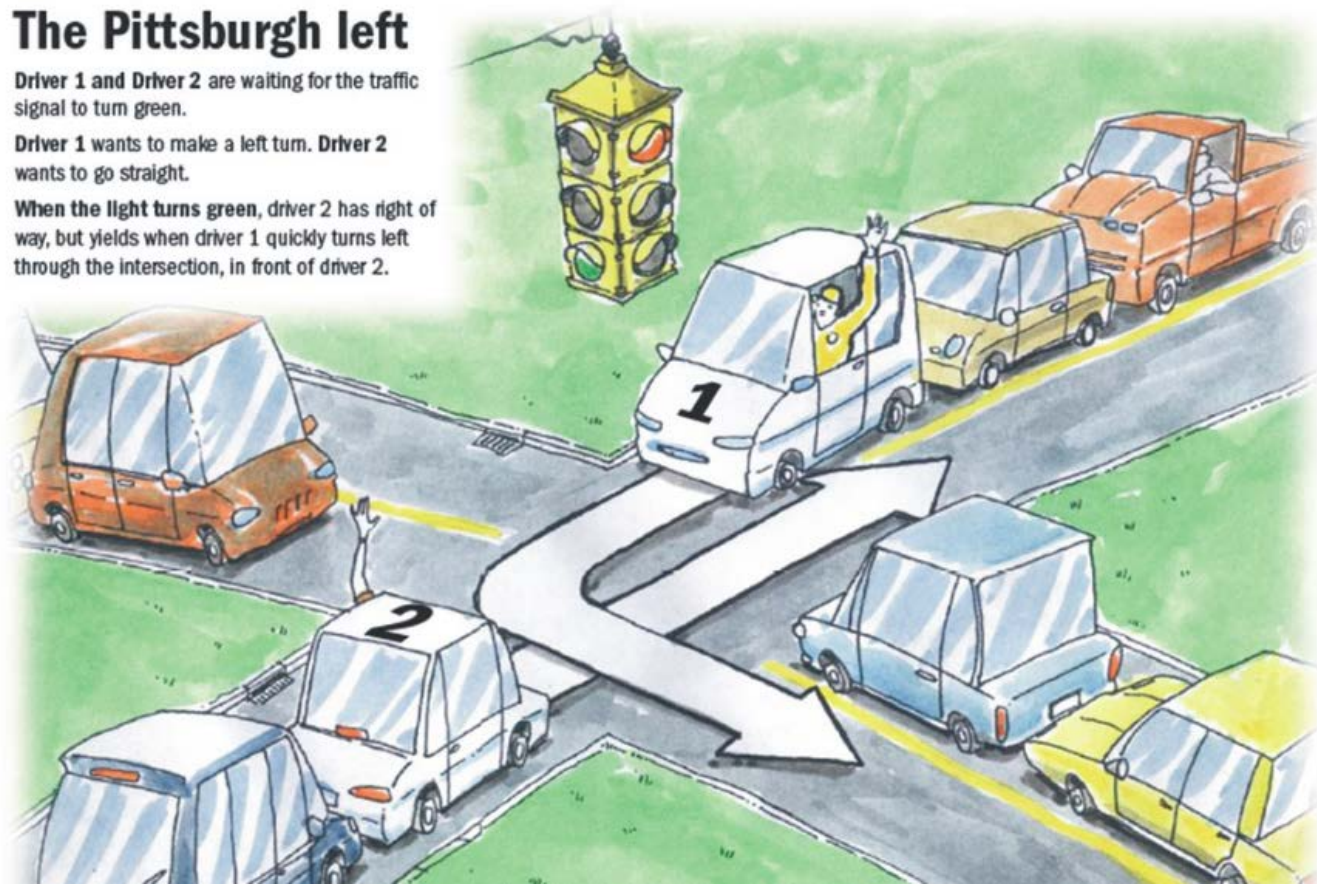# Have To Handle Cross-Product Of:

- **ODD**
  - Terrain, weather, navaids, road rules, …

- **OEDR**
  - People, vehicles, distractors (metal bridge joints), spills, balloons, …
  - Weird behaviors, crashes, wildlife, …

- **Manuevers**
  - Mode transitions, unusual traffic flow, …

- **Fault management**
  - Vehicle equipment faults, infrastructure faults, …
  - Violations of ODD/OEDR/maneuver assumptions, …

Cross left through
55 mph traffic for tunnel.
(Steep hill; no merge lane)
But first, stop.

[Google Street View]

Can We Really Tackle the Complexity?

- **Need to consider (ODD ✕ OEDR ✕ Manuevers ✕ Faults)**

- **Limit the cross-product space**
  - Geofencing is only a coarse start!

- **Deal with deviation from defined cross product**
  - Safe when environment forces you out of your design space
  - Design system to be robust when things go sideways

- **Build a system that knows when it is surprised**
  - Have to deal with "unknown unknowns"