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Vehicle Automation and the Duty to Act

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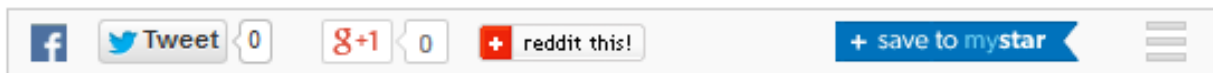
Virginia Center for Transportation Innovation and Research

21st World Congress on Intelligent Transport Systems

September 11, 2014

Driver causes crash to save four children crossing the street in Edmonton

Edmonton police are calling an alert driver a Good Samaritan for causing a fender-bender that saved four children crossing a busy street.



By: Chris Purdy The Canadian Press, Published on Tue Sep 04 2012

EDMONTON—Edmonton police are calling an alert driver a Good Samaritan for causing a fender-bender that saved four children crossing a busy street.

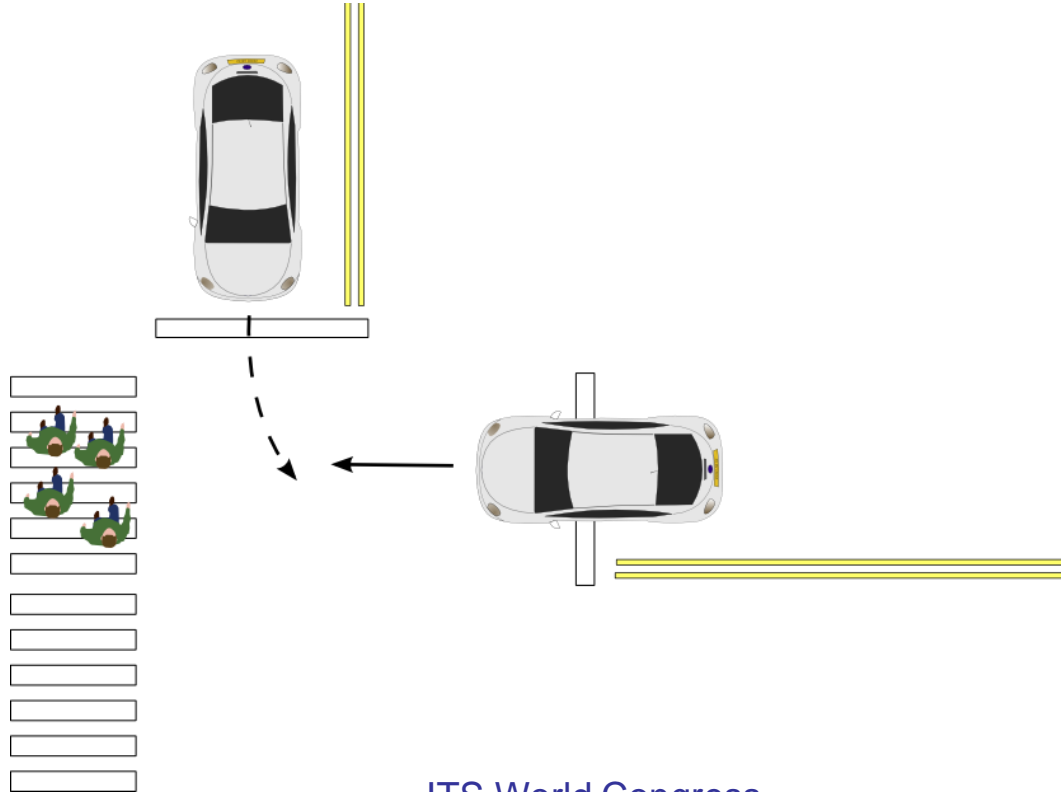
Darrell Krushelnicki is a bit stunned by the accolades and attention he's received since he intentionally crashed his Hummer last Friday outside a mall on the south side of the city.

But he said he'd do it again.

"Vehicles can always be repaired and replaced," the 46-year-old said Tuesday. "It's lives that are at risk. And I'm just glad it worked out for everybody."



Edmonton Crash



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ITS World Congress



Edmonton Crash

- Intervening driver suffered loose tooth
- Insurance did not hold driver liable
- Driver awarded bravery medal by Royal Canadian Humane Association
- Pedestrian: “If it wasn't for that guy, I'm pretty sure that I would be dead.”
- Police: “**Obviously it's not something we want to see people do**, but certainly his spontaneous actions may have saved the lives of four children.”



Calculating Risk

- Edmonton driver's decision was instant and instinctual
- What if he could make this decision ahead of time?
 - Estimated risk magnitudes
 - Historical probabilities of occurrence
 - Precise measurements of the environment

Now you can!

(kind of)



Calculating Risk

(12) **United States Patent**
Teller et al.

(10) **Patent No.:** **US 8,781,669 B1**
(45) **Date of Patent:** **Jul. 15, 2014**

(54) **CONSIDERATION OF RISKS IN ACTIVE
SENSING FOR AN AUTONOMOUS VEHICLE**

(75) Inventors: **Eric Teller**, San Francisco, CA (US);
Peter Lombrozo, Santa Cruz, CA (US)

(73) Assignee: **Google Inc.**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 235 days.

(21) Appl. No.: **13/471,184**

(22) Filed: **May 14, 2012**

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Cem Ünsal, Intelligent Navigation of Autonomous Vehicles in an
Automated Highway System: Learning Methods and Interacting
Vehicles Approach, Dissertation submitted to the Faculty of the Vir-
ginia Polytechnic Institute, Jan. 29, 1997, pp. 101-185.

* cited by examiner



Figure 4

- Discretionary move to get better data
- Patent weighs expected costs against expected benefits before moving

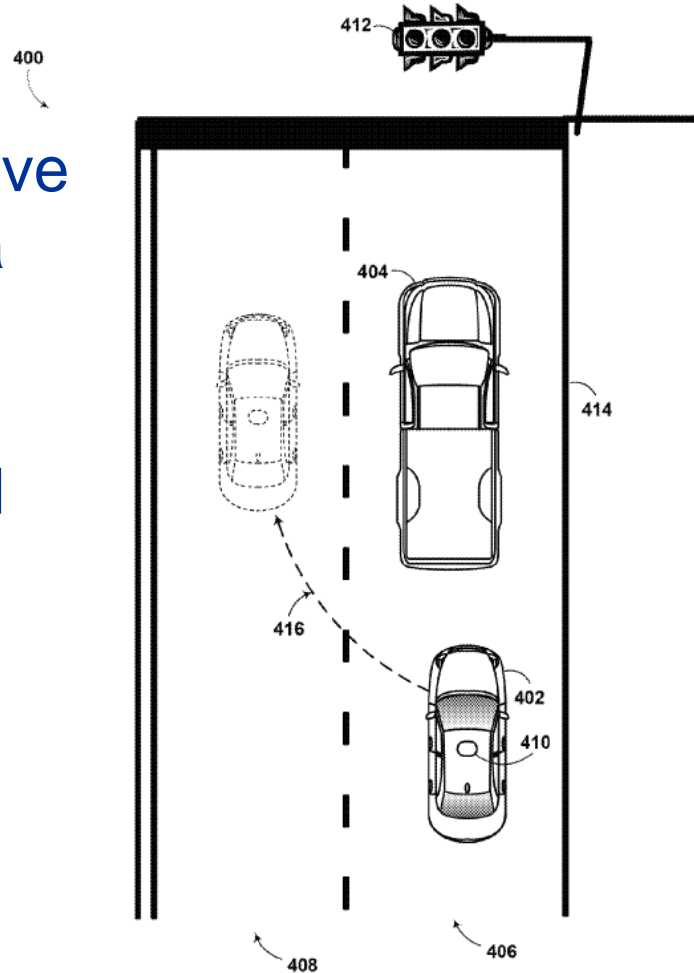


TABLE 1

Bad Event	Risk Magnitude	Probability (%)	Risk Penalty
getting hit by large truck	5,000	0.01%	0.5
getting hit by an oncoming vehicle	20,000	0.01%	2
getting hit from behind by vehicle (not shown) approaching in the left-hand lane 408	10,000	0.03%	3
hitting pedestrian who runs into the middle of the road	100,000	0.001%	1
losing information that is provided by camera in current position	10	10%	1
losing information that is provided by other sensor in current position	2	25%	0.5
Interference with path planning involving right turn at traffic light 412	50	100% (if turn is planned)/0% (if no turn is planned)	50/0



Magnitudes

- We need some values for bad event magnitudes, the “costs” of a maneuver
- Probably should not be based solely on liability or exposure to lawsuits
- Need some guidance on proper values
- Less about the crash, more about the steps leading up to the crash



Question:

Should an automated vehicle *ever* expose its passengers to a small risk to protect other road users?



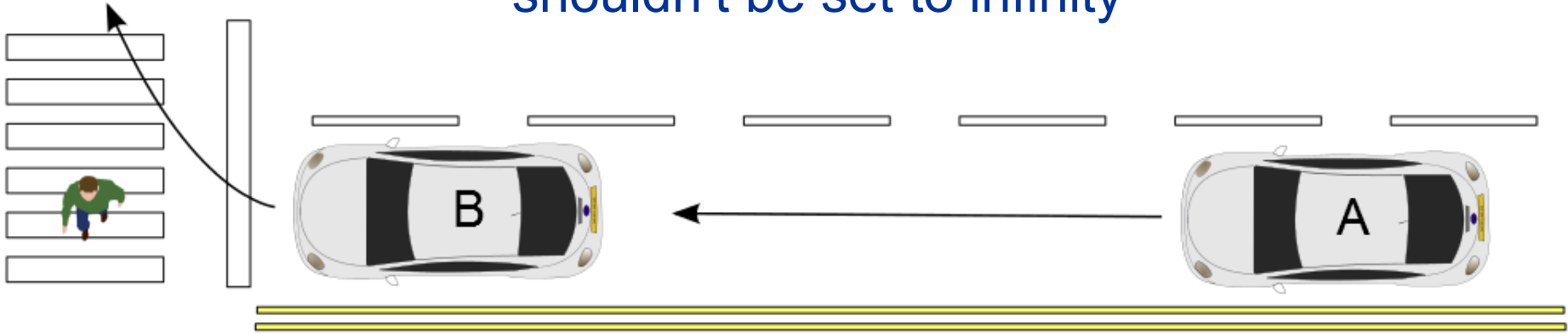
Legal Duty

- No duty to rescue in US common law
 - Assuming no special relationship between victim and bystander, and bystander didn't cause the danger
 - States may make exceptions



Moral Duty

The value of the automated vehicle passenger's life shouldn't be set to infinity



Should vehicle B avoid the speeding A, exposing the pedestrian to danger?

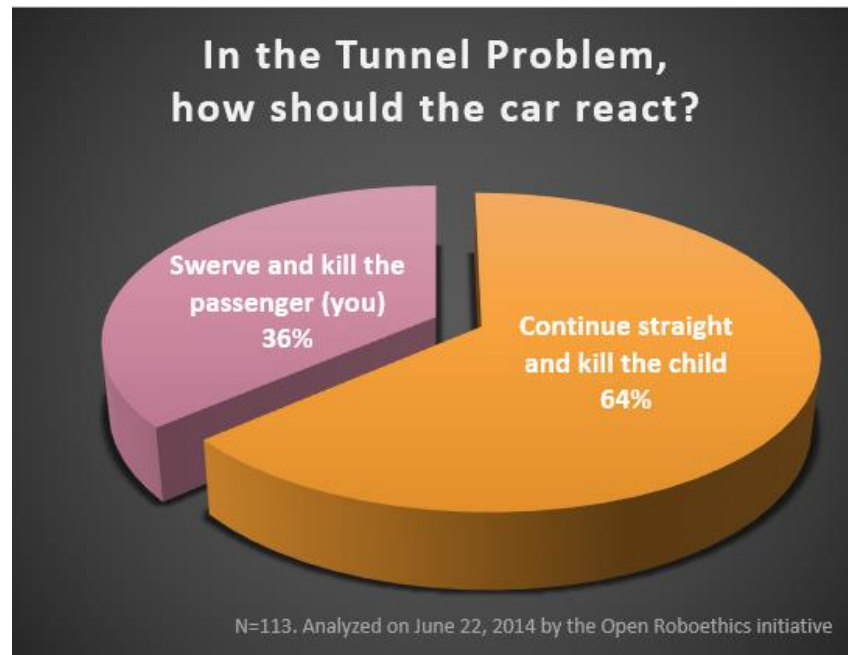
Normative Ethics

- Example: consequentialism
 - Maximize the expected benefit
 - Similar to the earlier patent
 - Difficult to define the benefit
 - Classical utilitarianism would require the automated vehicle protect the pedestrian






Descriptive Ethics

Just before entering the tunnel a child attempts to run across the road but trips in the center of the lane, effectively blocking the entrance to the tunnel. The car has only two options: continue straight, thereby hitting and killing the child, or swerve, thereby colliding into the wall on either side of the tunnel and killing you.



Descriptive Ethics

- What to do with the poll results?
 - Majority rules 
 - Perform action in proportion to response 
 - User-selected morals 
- These options all have weaknesses
 - Doesn't make it moral
 - Vehicle unpredictable, other AVs can't react
 - Complicated, reliance on default, game theory issues



Objections to Duty to Act

- Susceptible to deception
 - Throwing a mannequin into oncoming traffic
- Fault matters, but can be difficult to determine
 - Was the pedestrian breaking the law, or was he pushed into traffic?



Other Fields Often Combine Theories

- Military draft
 - *Lottery* and *instrumental value*, e.g. exemptions for farmers, students
- Organ donation
 - *First-come-first-served* and *sickest first*
- Radiation exposure
 - *Justification* (virtue ethics), *individual dose limits* (deontological ethics), and *optimization* (consequentialism)



Summary

- Automated vehicles will crash
- Pre-crash decisions will have an ethical component
- Little guidance on how to apportion risk among different road users
- Result will probably be a combination of different theories



Next Steps

- Start the discussion
- Automakers have incentive to protect their own occupants foremost
 - Is this ethical and/or legal?
 - If not, how to regulate?
- Code of ethics for automated vehicles





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