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# Autonomous Vehicles: Societal and Technological Evolution (Invited Contribution)

Christian Laugier

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# Véhicule autonome et ville de demain

## Technologie, business et société : quels enjeux ?

Nextdoor Issy Village  
41-43 rue Camille Desmoulins  
92130 Issy-les-Moulineaux  
Mercredi 14 décembre 18h30 - 21h00

Comment le véhicule va-t-il s'adapter à la ville de demain ?  
Et comment les villes vont-elles s'adapter au véhicule de demain ?

Pour appréhender le sujet dans son ensemble et  
entrevoir les risques et opportunités induits par cette « nouvelle » révolution,  
nous vous invitons à une table ronde animée par **Jean-Michel Normand**,  
journaliste au Monde, avec :



**Vincent Abadie**,  
Responsable Innovation et  
Technologies avancées,  
Aide à la Conduite,  
Maître-expert, **Groupe PSA**



**François Nédey**,  
Directeur technique  
Assurance Biens  
et Responsabilités, **Allianz**



**Didier Marginedes**,  
Senior Vice President,  
Blue Solutions, **Bolloré**



**Eric Legale**,  
Directeur de **Issy Media**,  
Société d'Economie Mixte  
chargée de la communication  
et des Technologies de l'Information  
de la ville d'**Issy-les-Moulineaux**.



**Emmanuel François**,  
Président,  
**Smart Building Alliance**  
for Smart Cities



**Christian Laugier**,  
First Class Research Director,  
**INRIA CHROMA** -  
Cooperative & Human-aware  
Robot Navigation  
in Dynamic Environments



**Olivier Babeau**,  
Economiste, Professeur des  
sciences de gestion,  
**Université de Bordeaux** et spécialiste  
des transitions numériques



# Cars & Human Mobility

## A Psychological & Technological evolution

On-going change of the role & concept of **private car** in human society



*Ownership & Feeling of Freedom*  
*Affective behaviors & Social position*  
*Driving pleasure ... but less and less true !*

*Next cars generation => Focus on **Technologies** for*  
*Safety & Comfort & Reduced Pollution*  
*Driving Assistance v/s Autonomous Driving*

### ❖ Context

- => Expected 3 Billions vehicles & 75% population in cities in 2050 (current model not scalable)*
- => Accidents: ~1.2 Million fatalities/Year in the world*
- => Driving safety & Nuisance issues (pollution, noise, traffic jam, parking ...) are becoming a major issue for both Governments & Industry*

- ❖ Technology & Internet progressively change de **mobility habits** of people  
*=> Shared mobility systems, more carpooling, more ADAS ...*  
*e.g. Uber, BlaBlaCar, Tesla Autopilot ...*

### ❖ A Huge ADAS market for Automotive Industry

*=> \$16 billions in 2012 & Expected \$261 billions in 2020 <sup>(f)</sup>*

<sup>(f)</sup> Forecasted US\$ 260 Billion Global Market for ADAS Systems by 2020. ABI Research. 2013.

# Autonomous Vehicles: 30 years R&D

Pioneer work at INRIA in the 90's : Autonomous parking, Platooning in cities, People mover (Cycab)



**1986 VaMors (Dickmann Munich U)**  
First autonomous vehicle on a road,  
Followed by EU project Prometheus



**2004 Darpa Grand Challenge**  
*Significant step towards Motion Autonomy  
... But still some uncontrolled behaviors*



**2007 Darpa Urban Challenge**  
*97 km, 50 manned & unmanned  
vehicles, 35 teams*



**2011 Google Car project**  
Fleet of 6 automated Toyota Prius  
140 000 miles covered on California roads  
with occasional human interventions

# Numerous real-life experiments ...but Safety is still insufficient => Some benign & serious accidents in the past few months (Google, Tesla ..)

**Autonomous Car:** Next generation technology & Expected market of 500 B€ in 2035



Tesla Autopilot based on Radar & Mobileye

- *Partnership with Mobileye uncertain*
- *Commercial option : 3400 € in France*



Costly 3D Lidar & Dense 3D mapping



Cybus experiment, La Rochelle 2012  
(CityMobil Project & Inria)



Drive Me trials

- *100 Test Vehicles in Göteborg, 80 km, 70km/h*
- *No pedestrians & Plenty of separations between lanes*



Driverless Taxi testing in Pittsburgh (Uber) & Singapore (nuTonomy)

*=> Numerous Sensors & Engineer in the car during testing*

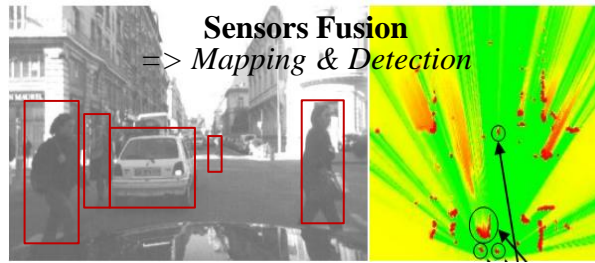


# Key Technologies: Embedded Perception & Decision

=> Decision-making for navigation while avoiding pending & future collisions



**Embedded Multi-Sensors Perception**  
=> Continuous monitoring the dynamic environment



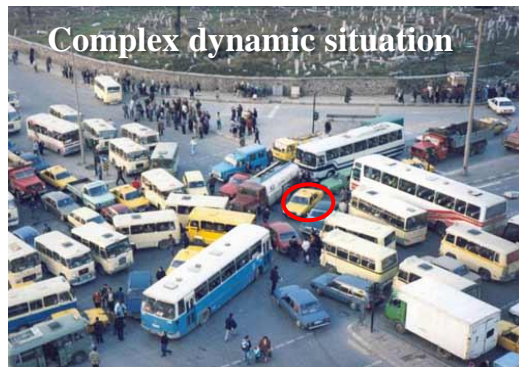
**Sensors Fusion**  
=> Mapping & Detection



**Scene interpretation**  
=> Using Context & Semantics



**Characterization of the Safe navigable space (local)**



**Complex dynamic situation**



**Human Aware Situation Assessment**



**Risk Assessment**

**Risk-Based Decision-making**  
=> Safest maneuver to execute

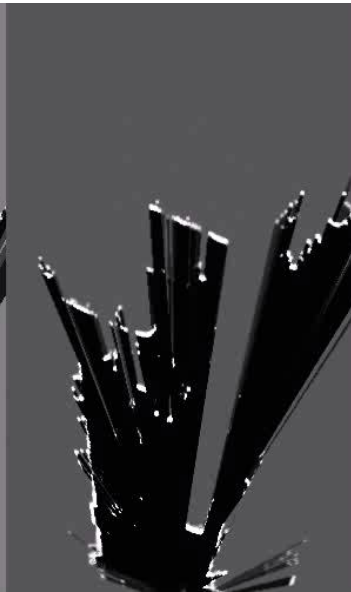
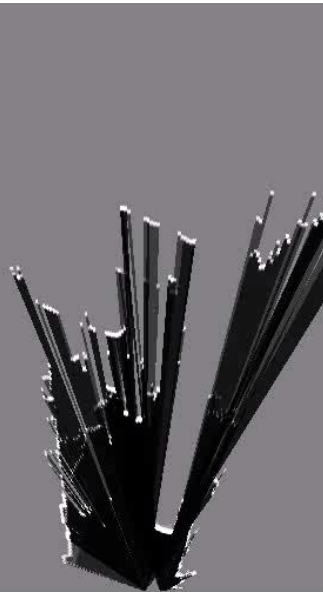
**Alarm / Control**

## Main features

Noisy data, Incompleteness, Dynamicity, Discrete measurements + **Real time Human in the loop & Environment change prediction required**

=> **Situation Awareness, Prediction & Risk assessment, Human-Vehicle Interactions**

# *Exploiting dynamics for Scene Understanding*



# Motion Prediction for collision avoidance (*Risk*)

=> *Detect future collision & Avoid false alarms*

Autonomous Vehicle (Cycab)



Parked Vehicle (occultation)

2005



**Urban street experiments**

=> Almost no false alarm (car, pedestrians ...)

2015



Other Vehicle

Mobile Dummy

Ego Vehicle

**Crash scenario on test track**

=> Almost all collisions predicted before the crash 0.5 – 3 s before)

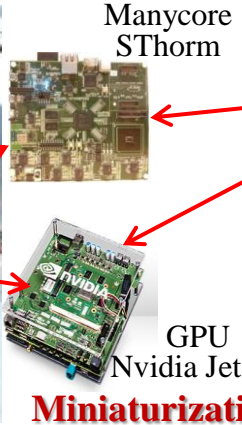


# Embedded perception & V2X Communication

*CPU+GPU+ROS / Stereo vision + Lidars + GPS + IMU + Odometry*



Toyota Lexus



**Miniaturization**



Renault Zoé



Integrated Perception Box  
*Movable & Connected*

