Why a LAVIA experimentation?

- In the 2000s, France is faced with a significant mortality on the road: more than 8,000 killed/y.
  - Analysis shows that excessive speed is a major cause of accidents.
  - Measurements show that drivers comply very little with speed limits.
- Public authorities understand that in conjunction with a sanctions policy alternatives such as ISA must be explored.
- After visiting the experiences underway in England, the Netherlands and Sweden, public authorities mobilize a French consortium to conduct a similar experiment (during the period 2001-2006).
Partnership

- **Research institutes**
  - LCPC (Laboratoire Central des Ponts et Chaussées)
  - INRETS (Institut National de Recherche sur les Transports et leur Sécurité)
- **Car manufacturers**
  - Renault, PSA
  - LAB (Laboratoire d’Accidentologie et de Biomécanique, Renault-PSA)
- **Public regional offices from French Ministry of Transport**
  - DREIF (Paris Region Infrastructure Directorate)
  - CETE Sud-Ouest (South-West Region Public Works Engineering Office)
  - CETE Méditerranée (Mediterranean Region Public Works Engineering Office)

LAVIA principles: operating modes

- **1st:** Advisory system
  - A warning is displayed on the dashboard if speed limit is exceeded (speed limit display is blinking).
- **2nd:** Voluntary active system
  - Throttle is under LAVIA control, such as speed limit cannot be exceeded but the system can be set OFF/ON at any time.
- **3rd:** Mandatory active system
  - Same as above, but the system is always ON.
- “Kick-down”
  - In both active modes, system can be temporarily disabled by pressing the accelerator past a point of resistance

NO EFFECT ON BRAKES
Technical aspects

- **How does it work?**
  - Autonomous system based on GPS, inertial sensors, digital map and speed database

- **Data acquisition**
  - 22 vehicles equipped with a data acquisition system to record driving parameters (speed limit, vehicle speed, driver actions etc.) every 500 ms
  - Among them, two prototypes equipped with a video and audio recorder to record front and rear views, driver’s face and conversation inside the car.

- **A trial zone near Paris (1000 km of road/street) with various speed limits, subdivided in …**
  - An active zone where both LAVIA and data acquisition operate
  - An observation zone where only data acquisition is active

Main project aims

- To evaluate the acceptability of the LAVIA system by the drivers
  - How do they use it in all its various operating modes?

- To evaluate its effects on driver’s behaviour
  - Induced speed reductions
  - Deviations from posted limits and KD usage

- To estimate the overall impact on user safety
  - Estimation of accidents and fatalities reduction on the basis of models and data collected during the experimentation
Was LAVIA precursor of what is known today as “FOT”?

• Yes! If we consider that a FOT is (at least):
  – A naturalistic driving experimentation in which the experimental conditions must generate a minimum bias,
  – During a period long enough such as the participant forget that they are in an experiment,
  – That produces a volume of data large enough to allow the construction of robust statistics

• But also:
  – But also a methodological framework for analysis that allows to decide on the acceptability, usability, usefulness and impact of the system that we want to evaluate.

April 21th, 2009

Experimental design: 4 dimensions

- Acceptance
  - a priori
  - a posteriori

- Safety impact

- Evaluation
- Usage
- Utility (speed reduction)

Survey before LAVIA usage, to understand driver’s opinion on speed, speed limiter

Surveys during & after LAVIA usage, to understand driver’s opinion on LAVIA and usage difficulties

92 drivers testing the different LAVIA variants, during 8 weeks. Estimation of LAVIA impact on speed reduction based on data analysis and comparison with vs. without the system

How do they use the system? 12 drivers testing the LAVIA in the presence of two observers

Fatalities and accident reduction estimation based on model and speed distribution

Survey before LAVIA usage, to understand driver’s opinion on speed, speed limiter

Survey before LAVIA usage, to understand driver’s opinion on speed, speed limiter
1st step: pre evaluation for qualitative analysis

- **Method**
  - 12 drivers involved in the study
  - Three driving trials conducted in the presence of two observers
  - Over and after the courses drivers were asked to verbally state their impressions and reactions to the various events encountered
  - Data, video and audio recording during trial 2 and trial 3
  - Trial 3: 72 km, 49.2% of urban road, 39.3% of rural road, 11.5% of motorways)
  - Data and video analysis

2nd step: evaluation in naturalistic driving conditions: quantitative analysis

- **Familiarization**
  - A three hours trip accompanied by a LAVIA driving instructor

- **Vehicle usage**
  - Vehicles made available to the test drivers during 8 weeks
  - First fortnight without LAVIA (neither advisory, nor active)
  - Subsequent fortnights to test the three modes: advisory only, active voluntary, active mandatory
  - Journey reason indicated by the driver at the beginning of each trip

- **Questionnaire after each mode tested**

- **Data logging to study system’s usage, driver’s behavior and speed limit reduction**
  - Data acquisition systems unloaded after 8 weeks
  - Post processing to eliminate erroneous recording
  - Statistical analysis
Modes, trips and data overall figures

- **Modes**
  - 79 days in neutral mode
  - 70 days in advisory and voluntary active modes
  - 73 days in mandatory active mode

- **Trips**
  - Total trip number: 15,911
  - Total # km: 130,000, average # trips/veh.: 177
  - Average trip length and duration: 8.3 km, 14 minutes

- **Data**
  - 26 M recordings, 73% in active LAVIA zone
  - 70,000 erroneous recordings, lack of map-matching in 6.2% of the time

Some evaluation results:

**Speed distribution over time**

- **30 km/h limitation (not shown here)**
  - Advisory mode is not efficient
- **50 km/h limitation**
  - Advisory mode is little efficient
  - Both active modes are efficient
- **90 km/h limitation**
  - All modes are efficient
- **All limitations**
  - Effect of active modes are very similar
Some evaluation results:

Safety impact

- If all cars were equipped with LAVIA, now

<table>
<thead>
<tr>
<th>LAVIA modes</th>
<th>Gain on fatalities/y</th>
<th>Gain on serious accidents/y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisory</td>
<td>120</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>4 %</td>
<td>2 %</td>
</tr>
<tr>
<td>Voluntary</td>
<td>250</td>
<td>340</td>
</tr>
<tr>
<td></td>
<td>8 %</td>
<td>4 %</td>
</tr>
<tr>
<td>Mandatory</td>
<td>170</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>5 %</td>
<td>3 %</td>
</tr>
</tbody>
</table>

FOT benefits: how the results have been used by researchers

- Method
  - LAVIA and other European projects have helped to define a methodological framework that was formalized in FESTA.

- Tools
  - LAVIA helped to develop new statistical tools appropriate to spatiotemporal data analysis.

- Quality
  - LAVIA allowed to gain experience on quality control on experimental process and especially on data from automated collection systems.

- Opening to the future
  - LAVIA allows the construction of extensive databases paving the way to other studies that were not foreseen at the beginning.
FOT benefits (continued)

- Ethical aspects: lot of lessons learned
- LAVIA/FOT
  - Leads to a better knowledge of the behavior of driving under the influence of an assistance system
  - Open the way towards a better understanding of the relationship between acceptability and attitudes across groups of drivers
  - Can detect changes in long-term behavior such as system recovery at the expense of safety.
- Finally LAVIA/FOT allows to develop new methods/model that establish the relationship between speed reduction and safety improvement
- Example of not foreseen study:
  - Impact of LAVIA on fuel consumption: very surprising results

Relationship within the consortium

- Convergence (although the ultimate objectives may differ)
  - The industry is interested to know that its system operates well, is acceptable, is effective and does not have adverse effects.
  - The researcher is interested to detect these problems in order to improve his knowledge on driver's behavior with/without ADAS.
  - All are keen to gain experience that can be reinvested later.
- Points of difference
  - The researcher wants to disseminate its results quickly while the industry is very careful especially if the results are mixed.
  - Difficulty finding a good compromise sharing of data from the experiment.
Impact on design of the system

• Ergonomics
  – The ergonomics of the system is well accepted: hence the terms of interaction with the drivers did not have to be modified.
  – However, the drivers confidence in the reliability and accuracy of the system is a key of acceptance.
  – The comparison with systems in other countries would have been interesting. The problem is to define a common reference enabling this comparison.

• However
  – The study on fuel consumption showed that we can not deal separately with safety and environmental impact. The driving assistance and the vehicle must be designed to optimize the whole.
  – Obviously, the manual gear box is not suited to LAVIA if we want to reduce fuel consumption.

The cost benefit analysis is of prime importance

• This has probably been underestimated in LAVIA
  – For too long it was believed that the deployment was only conditioned by technical or human aspects.

• In systems like LAVIA where there is a value chain involving a multitude of stakeholders, the business model is a crucial element that determines the deployment
  – The FOT must also validate the business model involving all stakeholders.
Some open questions?

- What are the prerequisites before starting a FOT?
  - Are they suited for technologies mature only (e.g., EuroFOT) or not mature as well (e.g., LAVIA)?
  - Prior starting a FOT, should we have a valid business model and a road map for deployment?

- Faced with applications becoming more and more complex involving many interactions between stakeholders (OEM, operators, PA, road managers), how to define the perimeter of the FOT?
  - What do we need to assess?

- What is the status of raw data?
  - Property of some partners only? Which one?
  - Open to all partners of the consortium?
  - Open to everybody (published on web site)?

Thank you for your attention