Airi ASSOCIAZIONE ITALIANA PER LA RICERCA INDUSTRIALE

nanotec IT CENTRO ITALIANO PER LE NANOTECNOLOGIE

Emerging and «emerged» technologies in Transportation -Successful application cases in the Automotive field

ROAD, RAILWAY AND SEA TRANSPORTATION

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AIRI Report 2012: Emerging and «emerged» technologies in Transportation - Successful application cases in the Automotive field

Agenda:

- Main goals for automotive industry to 2020 and related technologies
- Competitiveness through sustainable technologies
- CO_2 reduction: approaches
- Environmental sustainability: automotive research focus
- A successful case: Fiat ECO Drive
- Seamless connected vehicles: new paradigms per safety
- Automotive applications of Near Field Communication (NFC)
- Social sustainability: HMI for safety, comfort and entertainment
- Commonalities of research interest and needs among Transportation sector
- Conclusions

Main goals for automotive industry to 2020 and related technologies

"The European automotive industry is a key sector for the European economy, providing over 12 million jobs and a positive contribution to the trade balance of around € 90 billion (in 2011), which is essential for continued European prosperity".(*)

A strong and competitive European industry should provide:

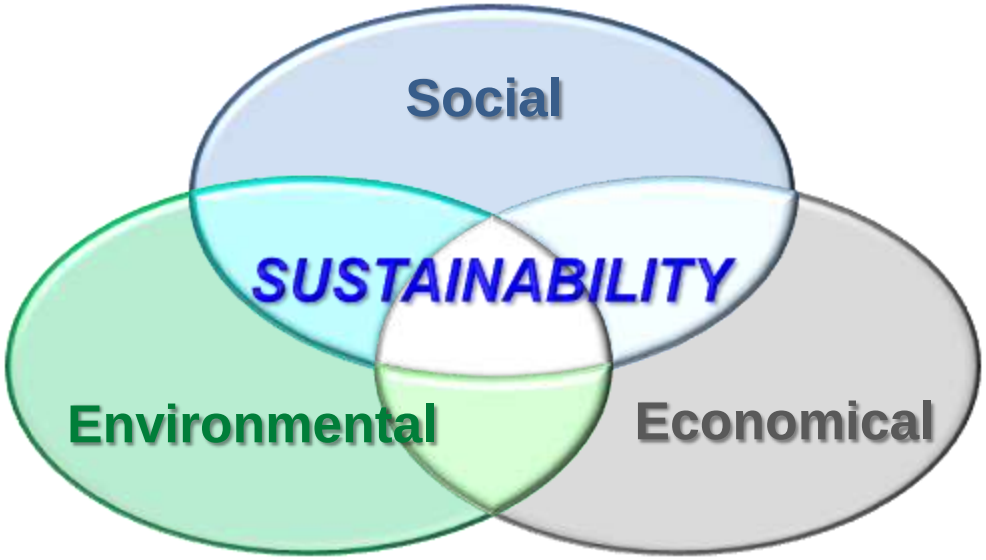
*"New vehicles purchased by EU consumers, which are **clean** in terms of regulated pollutants, more **fuel-efficient, quiet, safe and connected"***

*"A sector **exporting a larger portfolio of vehicles** to third markets, characterised by high-quality and high-technology"(*)*

From «CARS 21 High Level Group – Final report» on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union - June 2012

(*) Passenger trasportation in Europe: 83% by car, 7% by train; 10% by bus
(**) Only 1/3 of the total number of vehicle in the world are based in Europe

Competitiveness through sustainable technologies



- **Environmental Sustainability**: with a focus on reducing environmental impacts throughout the entire vehicle life cycle, from the use of raw materials to vehicle end-of-life, in order to reduce CO2, other emissions, and noise, while improving vehicle energy efficiency

- **Social Sustainability**: with a specific focus on all aspects of safety (active, passive and preventive) and on the development of efficient info-mobility systems designed to promote safe and convenient mobility for all

- **Competitiveness**: with a focus on vehicle architecture, performance, comfort and perceived quality, and on the use of innovative technology in production processes while ensuring affordability and **economic sustainability**

Competitiveness through sustainable technologies

In the context of National Research for Transport, the priority issues with significant impact for the competitiveness of the national economy, are:

- **Decarbonisation** by **integrated approaches** among vehicles manufacturers, suppliers of power/fuel systems, infrastructure managers and telecom providers
- Use of **lightweight/ lighted materials**, environmentally friendly, recyclable and low cost
- **Global safety** through **integrated management** based on extensive connectivity between vehicles and infrastructure
- Efficiency and effectiveness of the **global mobility system**, with particular reference to logistics and freight transport, through improved systems for management and intermodality

CO_2 reduction: approaches

The issue of reducing CO_2 emissions is probably the most important driver for automotive research over the coming years: the Regulation (EC) No 443/2009, in addition to setting the target of $130g_{CO2/km}$ for new car emissions in the period 2012-2015 it also set a target of $95g_{CO2/km}$ to be achieved in 2020.(*)

Reduction of CO_2 emissions can results from the following three actions:

- efficiency of conversion of the energy vector used (i.e. powertrain performance);
- global carbon footprint of the energy vector used
- energy used by the vehicle during operation, including integrated approaches that involve the driver and infrastructures

(*) Additionally, policy to move goods and passenger transporation by 50% from road to train and sea within 2050 is strongly fostered

Environmental sustainability: automotive research focus

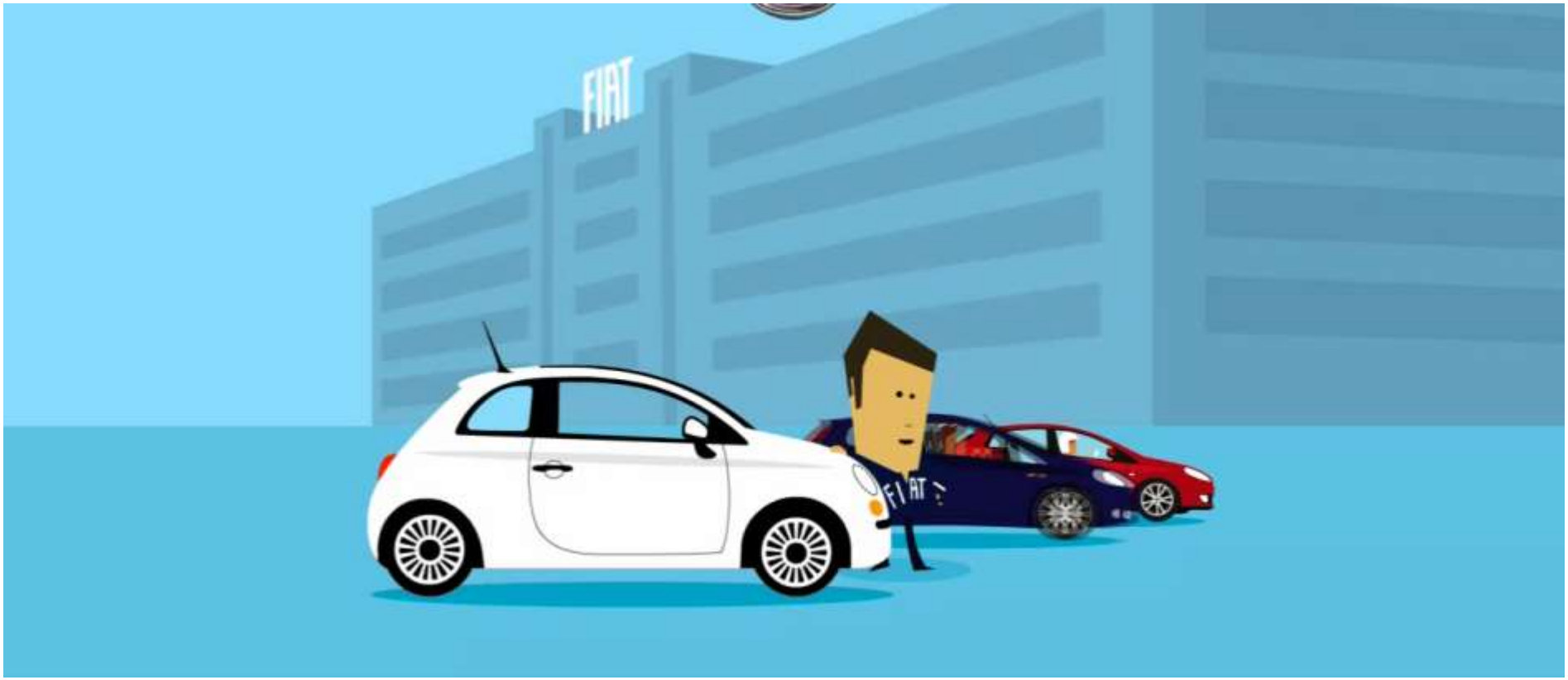
The research to improve **the efficiency of the vehicle** should focus on:

- aerodynamic drag coefficient reduction;
- rolling resistance (including friction and optimised tyre pressures) minimisation;
- deeper integration of vehicle and powertrain to optimise the on board energy management and achieve an higher electrification level toward a beltless engine;
- enhancement of the Stop&start function;
- **sustainable weight reduction**

and on solutions aimed at:

- recovering the kinetic energy when braking;
- waste heat re-use;
- reducing the distance travelled emitting fossil CO_2 by using low carbon content fuels;
- **assisting the driver with eco-driving aids**

A successful case: Fiat ECO Drive



A successful case: Fiat ECO Drive

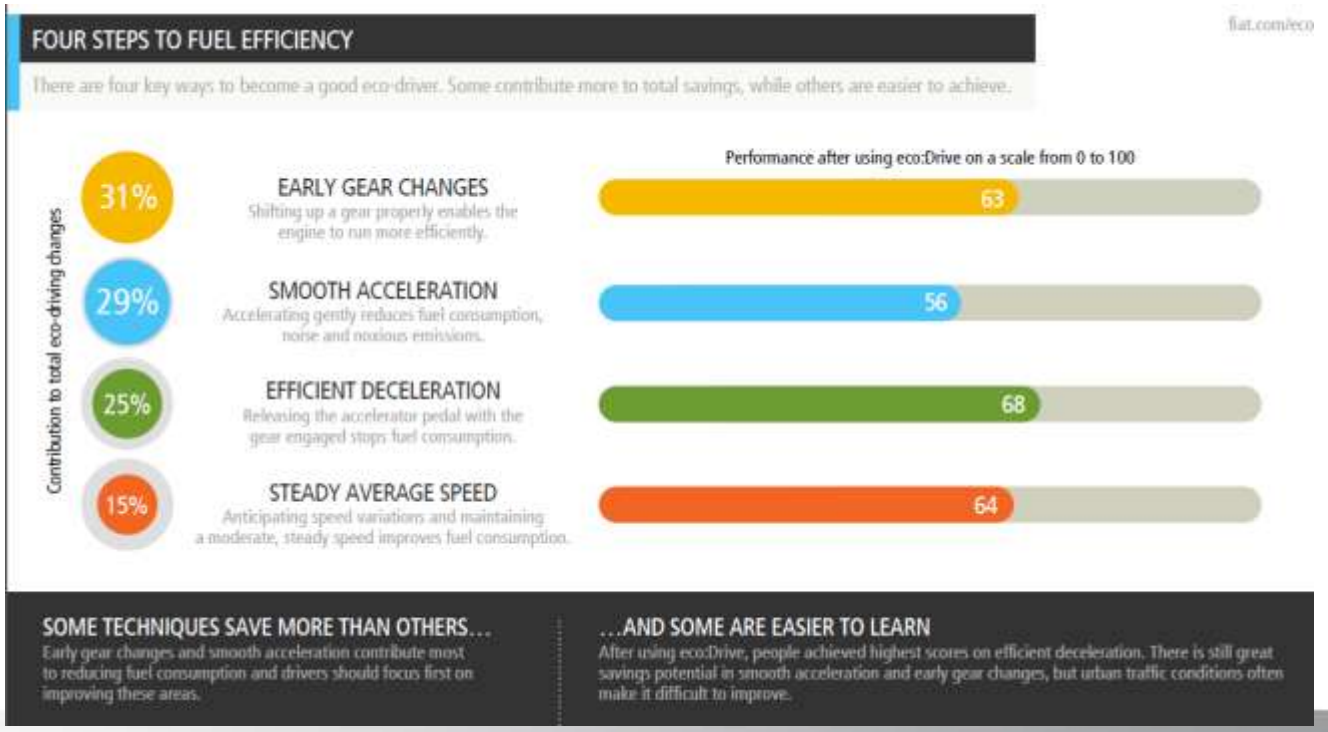
ABOUT THIS STUDY

Eco-driving can reduce CO_2 emissions by helping people to use less fuel. But how significant is this reduction, and how easy is it to achieve? Fiat studied thousands of journeys made by drivers using its eco:Drive tool, which helps people monitor their fuel efficiency and learn eco-driving techniques.

This was the first ever study of its kind, analysing real journeys made on real roads, by real drivers going about their everyday lives. These slides explore how easily people learned to eco-drive, the external factors influencing their efficiency – and the potential savings to be made.

428,000 journeys | **5,700** drivers | **150** days | **5** countries

A successful case: Fiat ECO Drive



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A successful case: Fiat ECO Drive

Eco DRIVE Live

A successful case: Fiat ECO Drive

In future the eco-driving approach can be extended by integrating additional eco-related information:

- *based on the electronic horizon (geometry and attribute of upcoming road segments) and the position of the car, not excluding the possibility to move data and calculations "on the cloud"*
- *that may derive from sensing and exchanging information on surrounding driving conditions, with the roadside infrastructures, traffic control centers and social interaction among vehicles.*

Environmental sustainability: green materials

- The **weight reduction** is the most direct way **to reduce the fuel consumption** and consequently **the emissions.**

  It is estimated that a reduction of 10% of the vehicle weight leads to a reduction of fuel of approximately 7%. So for every kilogram of weight saved, the yearly CO_2 emission is reduced by approximately 20 kg.

LIGHTWEIGHT & LIGHTENED ADVANCED MATERIALS

- **REDUCE, REUSE AND RECYCL**: sustainability strategy to reduce the environmental footprint and accelerate the global development of advanced fuel-efficient vehicle technologies.

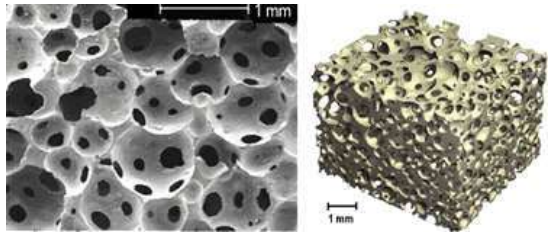
GREEN MATERIALS

Environmental sustainability: green materials

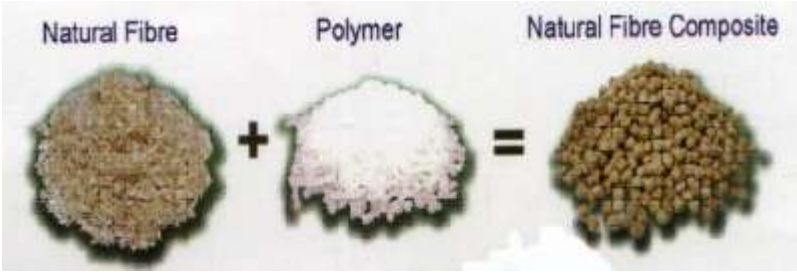
Trends in Materials Use

- Decreased steel use
- Increased plastics, composites, and lightweight metals use
- Reduced toxic materials
- Increased recyclability

STRUCTURAL MATERIALS
lightweight metal alloys (on aluminum, titanium, magnesium), metal foams



NON STRUCTURAL MATERIALS
glass, polymers and bio composites



Environmental sustainability: green materials

BIO-BASED MATERIALS FOR AUTOMOTIVE INDUSTRY

One area of focus for **innovation of future cars engineering is bio-based materials applications**: a significant opportunity for **reducing environmental impact** of car parts is represented by the adoption of bio-materials derived from renewable resources to replace traditional petroleum-based plastics

Create polymers

BIOPOLYMERS

- **Feedstocks: soybean, castor bean, corn, and sugar cane.**

- **Fermented**
- **Conversion processes**

Reinforcement and fillers

BIOCOMPOSITES

- **bast fibers:** hemp, kenaf, flax →

- **wood sources or crop residues**

- **leaf fibers:** sisal and banana fibers →

Environmental sustainability: green materials

BIO-BASED MATERIALS FOR AUTOMOTIVE INDUSTRY

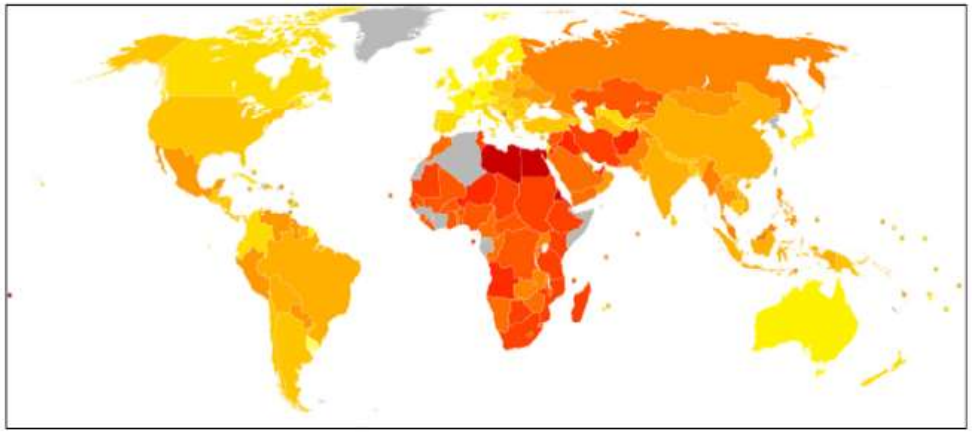
- **Low density → light-weighting applications:**
  - Decrease of fuel consumption
  - Decrease of CO_2 emissions
- **Comparable or even better properties** in respect to traditional materials
- **Eco-friendly technology:**
  - More natural fibers, less petroleum-based polymers
  - Production cycle of the fibers: reduction of CO2
- **Green marketing**

Social sustainability: new paradigms for road safety

Road safety is a major societal issue all over the world, the rate of fatalities caused by road accidents is huge in all countries and the large majority of the **1,7 million of road fatalities** worldwide occur in low income countries.

In 2011 the European Commission established a challenging goal for road safety:

- to move close to zero fatalities in road transport by 2050. In line with this goal, the EU aims at halving road casualties by 2020.



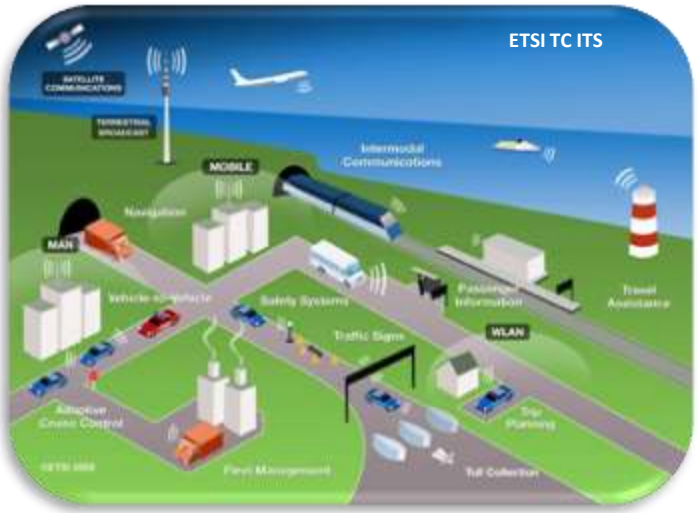
Traffic related deaths: annual number of road fatalities per 100,000 inhabitants [sources: List of OECD countries by traffic related death, World Health Organization, road traffic injuries]

Social sustainability: new paradigms for road safety

- **Human factor studies** highlighted that the great majority of road accidents involve some form of driver error, related in particular to inattention.

- The **challenge** is to prevent such errors, or mitigate their consequences, providing drivers with information or warnings on potential hazards, or even intervening by automatic steering and/or braking.

- The **next generation of support systems** shall:
  - **integrate** key enabling technologies: advanced sensing, novel driver vehicle interfaces, vehicle connectivity and positioning.
  - **combine** safe, green and efficient driving to maximise drivers' adoption.



Social sustainability: new paradigms for road safety

Around 90% of road accidents are caused by drivers distracted or inattentive

Preventive & Active Safety

Development of **affordable and integrated driver assistance systems**

- Advanced AEB (Autonomous Emergency Braking) and VRU detection
- Driver attention, detection and support

- **Investigation of affordable technologies to cover also challenging scenarios (e.g. child crossing the road starting from a hidden point)**



- **Development, in-vehicle integration and assessment**


- **Driver in the control loop**


Social sustainability: new paradigms for road safety

Seamless connected vehicles

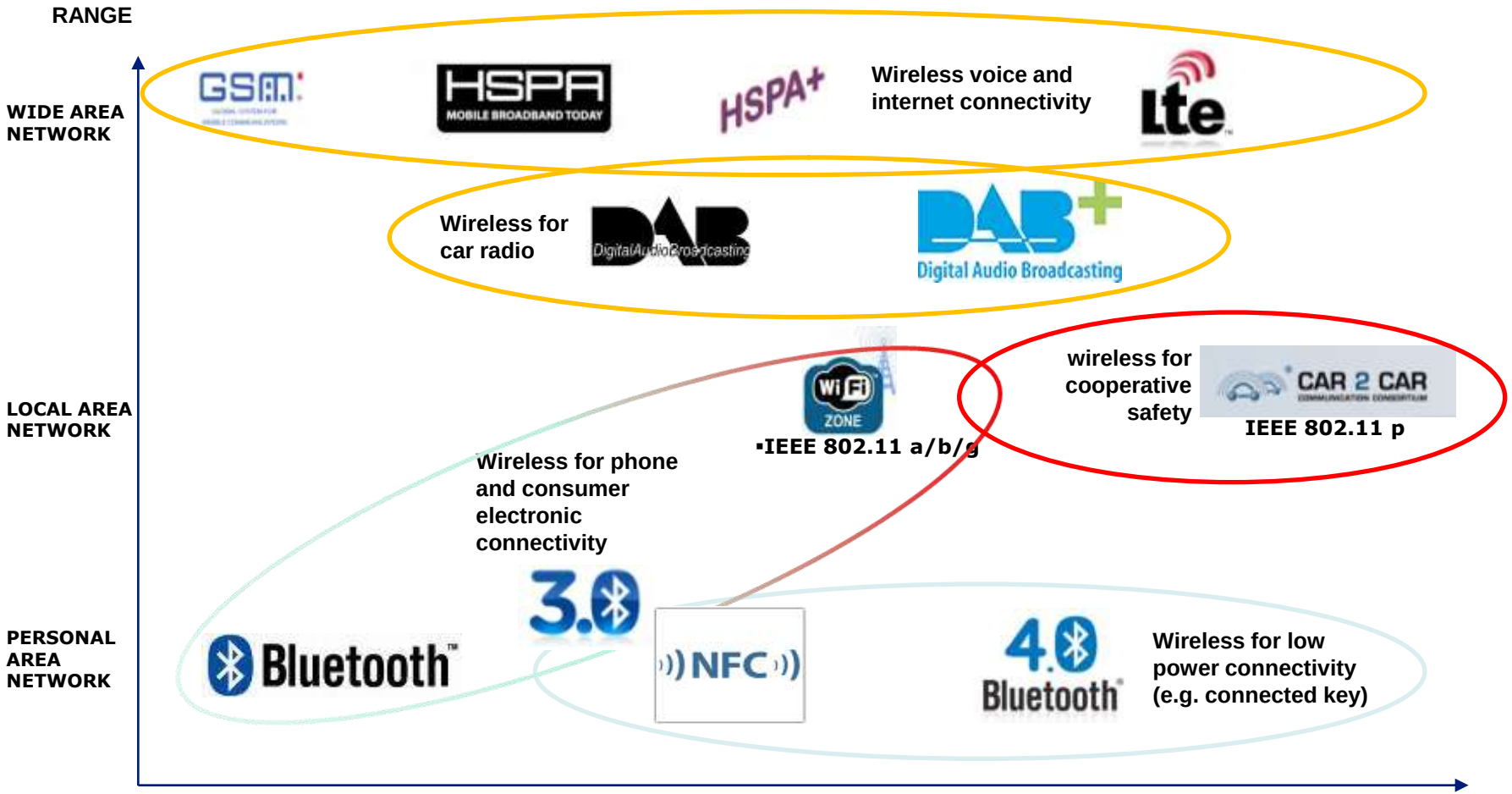
Connected vehicles extend drivers' and sensors' lines of sight and can see hidden dangers: cooperative systems have not the limit of the standards sensors, radars and cameras, in terms of perception: they could "see" also behind a curve, or in dense fog, all vehicles in the communication range are detected (electronic radar).

Then they have a considerable potential in terms of accident reduction.

By the way, all vehicle have to be equipped: full penetration is needed.

Social sustainability: new paradigms for road safety

Roadmap of wireless communication technologies



Social sustainability: new paradigms for road safety

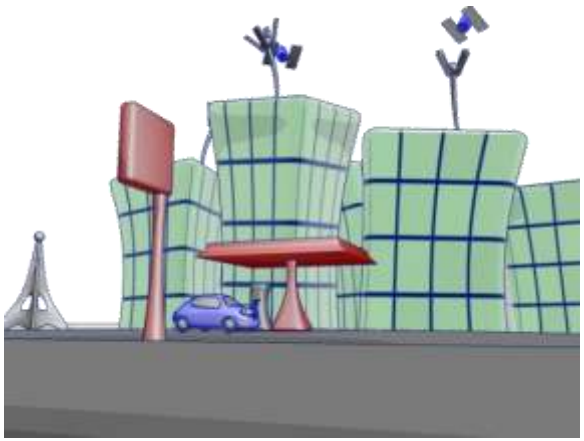
3G/4G, LTE cellular network (eCall in-vehicle platform)

Short range communication (802.11.p)

Galileo augmented vehicle positioning

Traffic data management based on cloud computing

Dynamic electronic horizon for
preventive safety,
green and efficient driving



Seamless connected vehicles: new paradigms for road safety, green and efficient driving

Connected vehicles & Future Internet IPv6 will enable the “APPs” approach for a positive cost/benefit ratio:

- Traffic jam ahead
- Emergency vehicle approaching
- Slow vehicle warning
- Post crash warning
- Obstacle warning
- Motorcycle warning
- Insurance and Financial Services
- Dealer Management
- Point of interest notification
- Fleet management
- …

Automotive applications of Near Field Communication (NFC)

OEMs, telecom operators and smart phone providers are the key stakeholders for NFC (Near Field Communication).

Investigations on integration of NFC technology in the automotive environment is a theme which has been developed within the cooperation between CRF and Telecom Italia

The smartphone is the main target of the NFC technology, which can be imagined as a wallet where the user "rights" are stored. Among these rights there could be the vehicle access code. In such a way the phone becomes the vehicle key.

Automotive applications of Near Field Communication (NFC)

Possible use cases

1. The owner of the vehicle uses his phone as the vehicle key (doors/ immobilizer).
2. The owner, by the means of a web service, can decide to enable the other user's phone for the vehicle usage.
3. The owner can decide to revoke the vehicle credentials from the phone of the user, who receives another self-installing message. The user has therefore no access to the vehicle

Automotive applications of Near Field Communication (NFC)

Additionally, other functions can improve the offer:

- **Personal Settings** seat, steering wheel, radio stations, etc. are automatically adapted to personal configurations stored into the NFC mobile phone.
- **Car diagnosis** related information can be accessed via an NFC mobile phone.
- **Car rental:** the car user gets a time limited (software) key via an NFC mobile phone.
- …..

Social sustainability: HMI for safety, comfort and entertainment

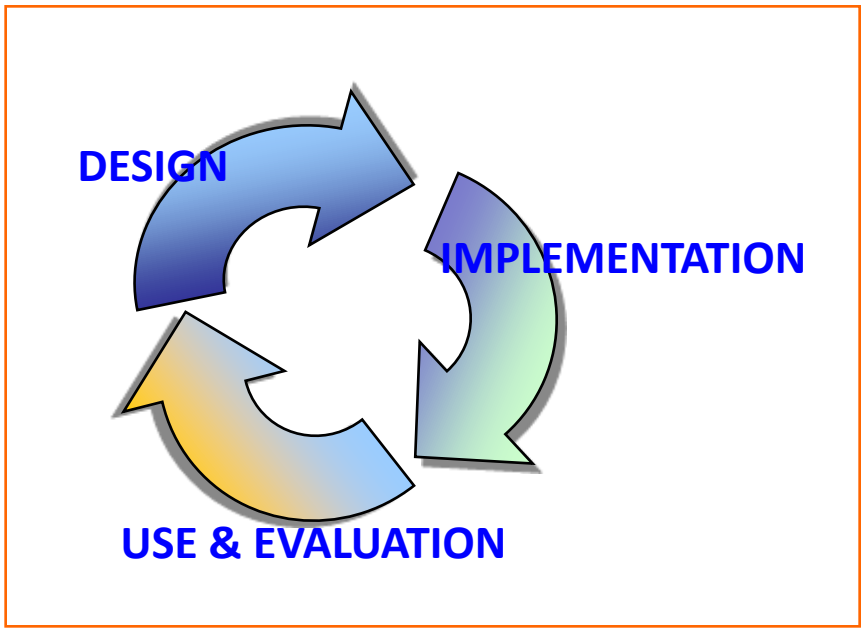
The way drivers interact with their cars is evolving and Automotive HMIs are influenced by global trends in several key areas: personal mobile devices, consumer electronics, car technology, demography, economy and legislation.

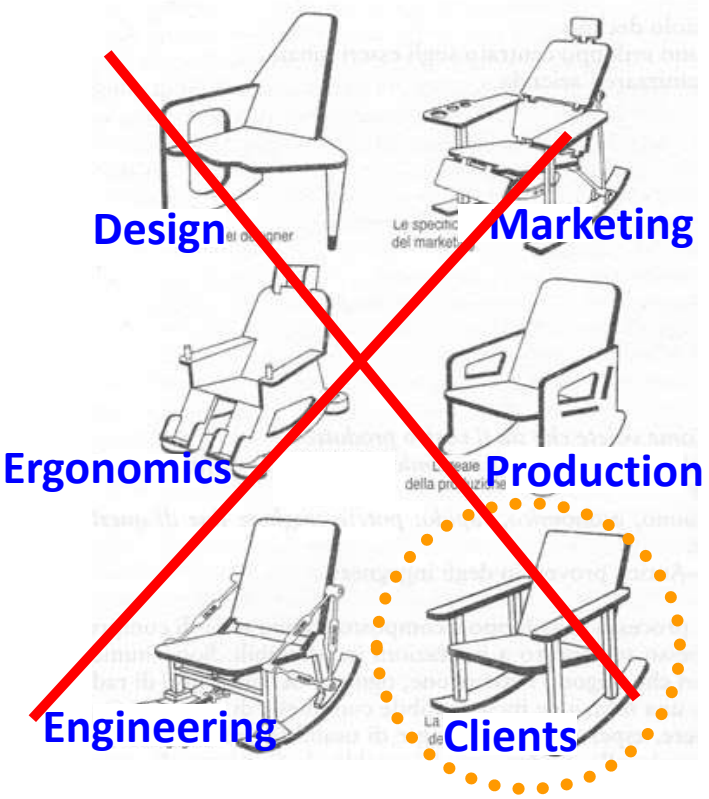
The interaction between driver and vehicle begins the instant one unlocks the car door, continues while driving, and ends the moment the driver gets out and locks the car. **It involves the optimal balance of the driver's sensory inputs to make the driving experience both safe and enjoyable.**

USER EXPERIENCE AND USER-CENTRED DESIGN

User-Centred Design

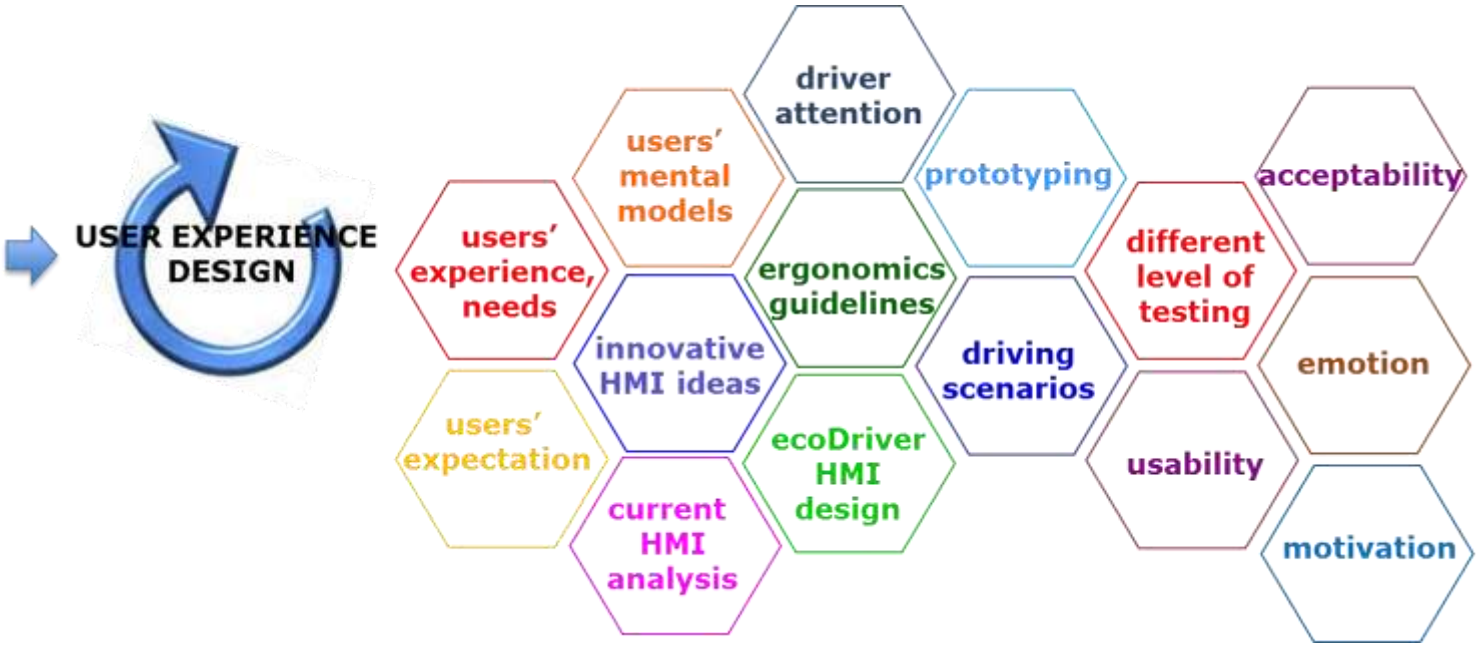
The User-Centred Design process is the base to realize products with HIGH USABILITY





Social sustainability: HMI for safety, comfort and entertainment

User experience design:
deliver drivers the most effective feedback on green driving optimizing the driver-powertrain-environment feedback loop



driver's behavior
is fundamental in green driving

Social sustainability: HMI for safety, comfort and entertainment

User experience design: users/experts involvement to design, evaluate and improve green driving system

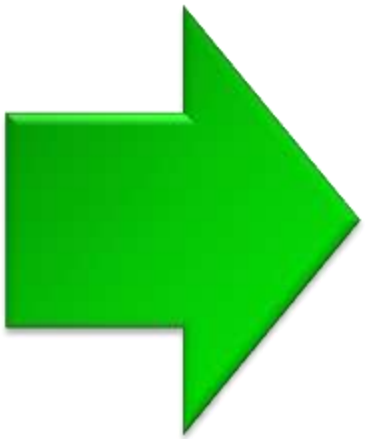
data already available

users' experience, needs, expectations

user tests on multiple visual icons/layouts: selected solutions with better adequacy, comprehension and lower level of complexity

users' usability judgments and performances, driving with visual & haptic HMI in simulated scenarios

Social sustainability: HMI for safety, comfort and entertainment



green driving

identification of the HMI solutions

for an adequate **compromise**

among

consumption, mental effort, usability, acceptability in the green driving system

Commonalities of research interest and needs among Transportation sector: Sea Transportation Technologies

- Solution&Technologies **to reduce** ships **air pollutions**
- Solution&Technologies **to improve Energy Efficiency** on ship systems
- Alternative technologies **to generate Power** on board
- New **methodologies for ship design** and **Multi-disciplinary Virtual Analysis** techniques to reduce time-to-market
- Solution&Technologies **to optimize Comfort** on board
- Technologies for **Controls** and **Security**

Commonalities of research interest and needs among Transportation sector: Rail and Multimodal Transportation Technologies

- Solution&Technologies **to improve Energy Efficiency** on railroad systems (Green Technologies)
- Systems with high **Enviromental Sustainability**
- ***Information, Security & Safety*** technologies
- Architecture/system for **Safety and security** to optimize Performance, Costs & Benefits
- Improvement in **Quality and Efficiency** of processes for people and goods transportations..

Conclusions

- Among the “emerging” technologies analyzed in 2012 AIRI report for the automotive sector, those related to **Communication** and **Advanced Materials** have growth of interest further in the last months

- **Communication techs** are key enablers not only for new infotelematics services on board but, at the same way, for preventive safety evolution and eco-driving

- Integration of **Communication technologies & precise positioning** (e.g. Galileo network of satellite), the future **Internet IPv6** and **cloud based computation** will enlarge the offer of automotive functionalities in the next years

- In this highly evolutionary contest, the AIRI network can offer opportunities of cross-fertilization among Sectors and the bases for joined partecipation to National/Europen funded Programme (e.g. Cluster Tecnologici Nazionali)