A window on future technology

From science fiction to reality

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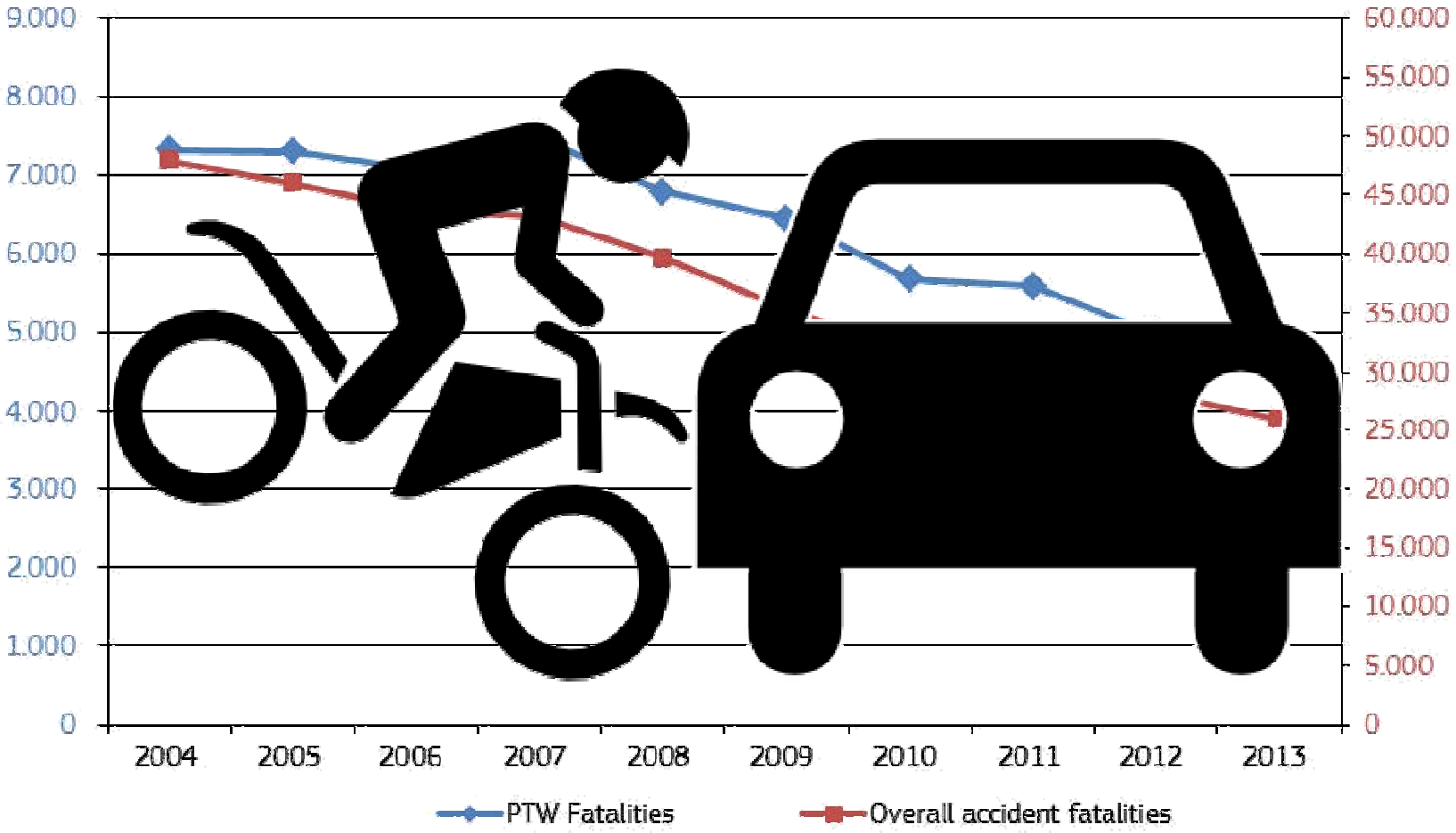
Observations on road safety



2013 report: ≈26.000 road fatalities in the EU: the trend is decreasing, but Powered Two Wheelers (PTW) accounted for the 18% (15% in 2004).

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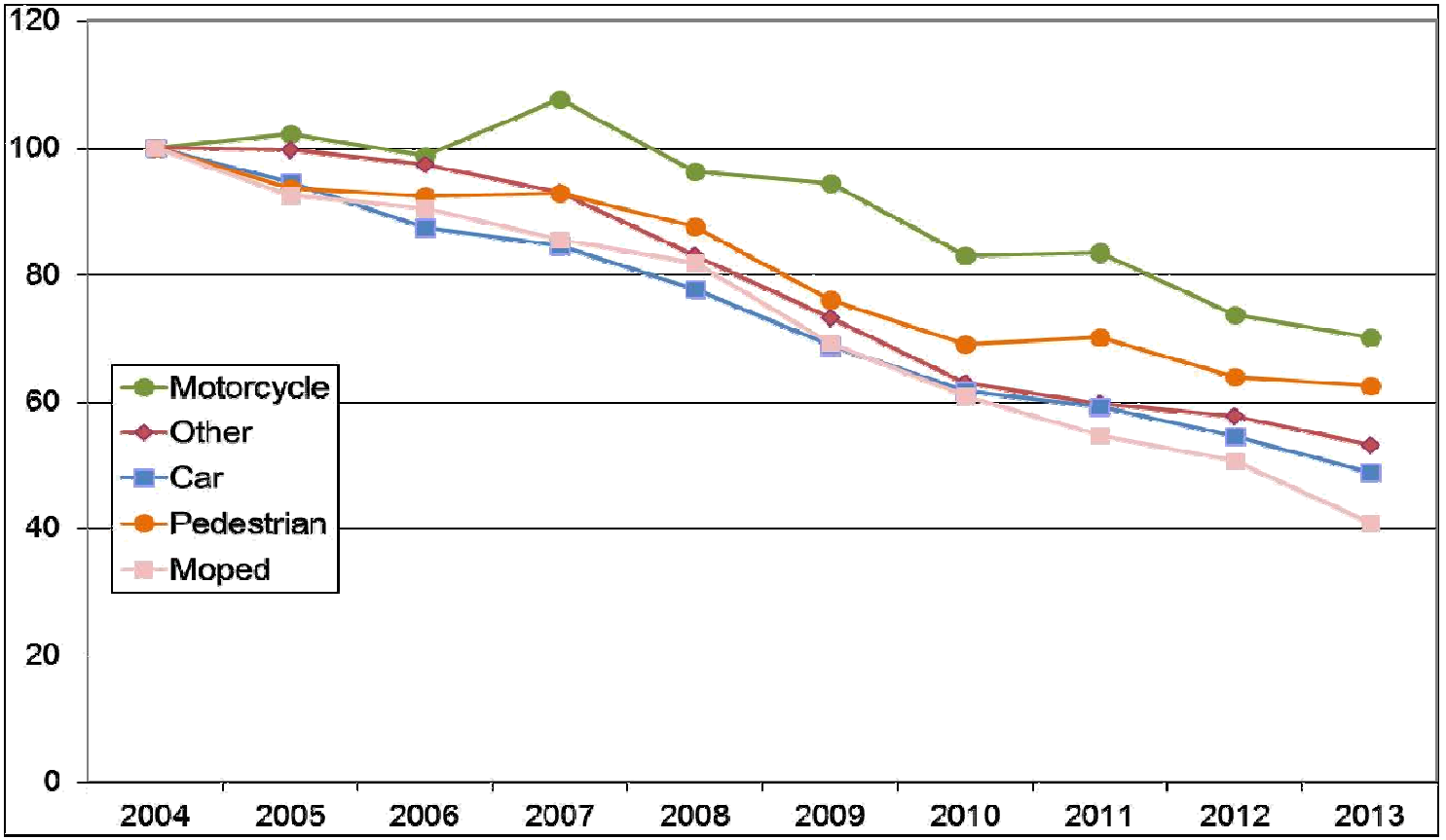
(source: European Road Safety Observatory –Traffic Safety Basic Facts – 2015)

Observations on road safety



PTW accidents are decreasing less: ***General conditions are improving but interventions are not well focused on the PTW safety.***

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(source: European Road Safety Observatory –Traffic Safety Basic Facts – 2015)

Aims for road safety

The EU aims at halving the road deaths observed in 2010 by 2020.

What for motorcycle?

Motorcycle and road safety

Main factors of influence in road accidents:

- Rider
- Environment
- Vehicle

Road safety: the current solutions

- Rider: Personal Protective Equipment (PPE)
  (i.e. protecting clothing, helmets, armour, gloves, air bag etc.)
- Environment: Infrastructure design and control
  (i.e. road condition, traffic, signals, protection etc.)
- Vehicle: Motorcycle device and systems
  (i.e. ABS, Traction Control Electronic Suspension etc.)

The rider safety

Any best-practice in modern road safety focus on rider.

Rider is a **Vulnerable Road User**

Whenever a large heavy vehicle comes into close proximity of a vehicle or person who has a very limited possibility of defence, could a collision occur in which smaller vehicle or individual is more vulnerable to injury or fatality.

A new attitude towards road safety

The attention should be moved on the rider, analyzing the competencies and the behavior during riding.

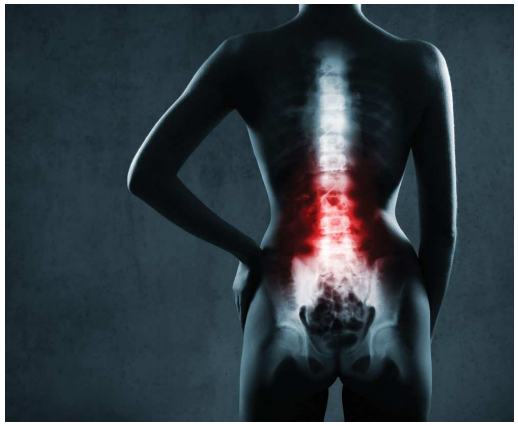
Human performance and attention influence the level of safety

- Inattention while riding, or the failure to attend to important information, is a major contributor to 20% of road accidents for PTW (Walter et al, 2012).
- Attention levels influence the ability to perceive and be aware of potential hazards, which in turn affects riding behavior
- A pro-active measure of attention levels may be a key factor for an innovative road safety action.

Factors influencing human performance while riding

Drowsiness

Attention



Fatigue

Level of stress

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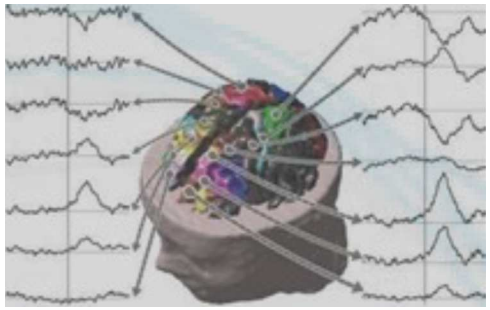
Human performance monitoring

Some parameters extracted from physiological measurements can give insights on attention, drowsiness, distraction, fatigue…

Physiological measurements

- Electroencephalography (EEG)
- Electrocardiography (ECG)
- surface Electromyography (sEMG)
- Eye movement
- Electrodermal activity

Physiological measurement: Electroencephalography



Electroencephalography (EEG) is the recording of the electrical activity spontaneously generated by cerebral cortex neurons.

- measurements performed by using electrodes placed on the scalp

Can be used to monitor:

- attention levels and mental fatigue;
- affective states and performance level;
- different associative attention-based strategies;
- responses to stimuli.

EEG can be used in Brain Computer Interface (BCI) as a direct pathway between intention and devices.

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Physiological measurement: Electrocardiography

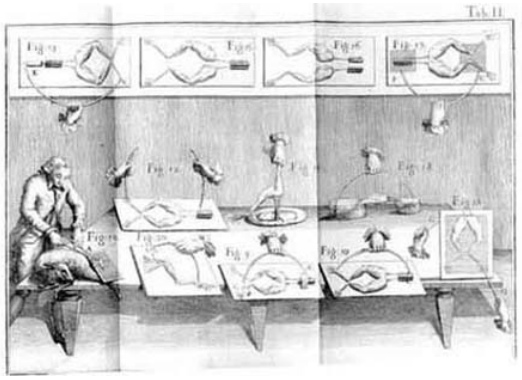
Electrocardiography (ECG) is the recording of the electrical activity of the heart.

- measurements performed by using electrodes placed on the skin

The cardiac signal gives information about:

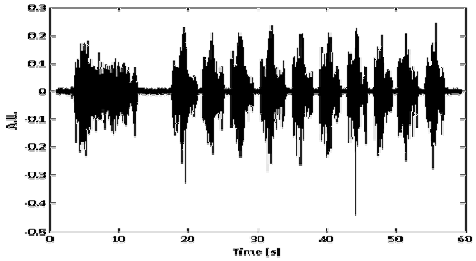
- Heart Rate (HR)
- HR variability as a marker of vagal firing and then of attention level.

Physiological measurement: Electromyography



Electromyography (EmG) is the recording of the signal associated with electrical muscular activity.

- Surface measurements (sEmG) are performed by using couple of electrodes placed on the skin



sEMG during riding can be used to:

- assess muscular fatigue;
- evaluate the muscular force exerted ;
- evaluate adopted strategies after events stimulating the rider.
- Anticipatory Postural Adjustments.

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Physiological measurement

Eye movement data

- fixation duration
- fixation location
- fixation patterns
- blink rate.

Electrodermal activity and skin conductance

- level of arousal;
- stress;
- activation of the rider.

Kinematic and dynamic data

Inertial Measurement Units (IMU)

accelerometers and gyroscopes can be used to record kinematics of arms and thorax to describe posture and movements.

Force measurement

Dynamometers can be used to measure forces applied by the human body to the vehicle during riding to monitor equilibrium and reduce neuromuscular damages.

The analysis of posture modifications together with the assessment of incorrect postural habit could integrate data dealing with fatigue at the central level and explain behavioral modifications.

Riders' quality of experience

Use of minimal invasive instruments to not interfere with the riding experience

Wearable sensors

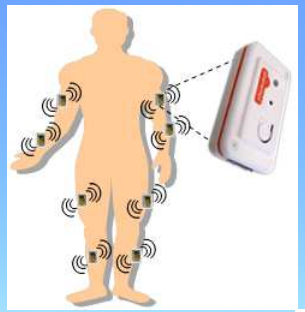
- Small size
- Easy wearing
- Comfort
- ….

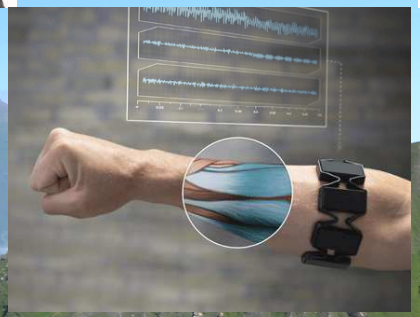
Human machine interface

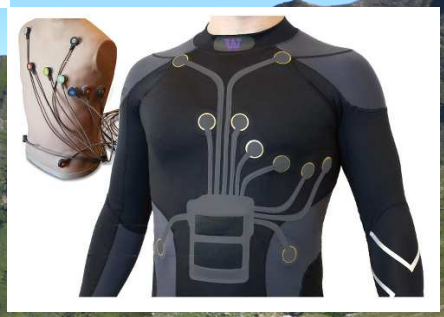
- Helping human function when needed

Riders' quality of experience: minimal invasiveness

Wearable sensors







Human machine interface

A Pilot Study

RIDE: Remote Intention Detecting Emulator @Biolab3

RIDE is a system designed in our Lab for the remote activation of the motorcycle electronic controls.

- It integrates a brain computer interface (EEG) in a helmet connected with the bike.
- RIDE could automatically activate the turn indicators, while the pilot approaching a turn
- RIDE could intervene on the engine mapping, in hazardous perceived conditions.
- The EEG waves are real time classified associating pre-defined response to stimuli (i.e. Thinking arrow = curve approching)

Honda European Mobility Innovation Contest 2016 winner - Honda R&D Europe (Italy).

Conclusions

Today

Many data of motorcycle, sensors, environment…

More data on rider performance can help to reduce risk while riding

- In this framework, the study of the relationship man-vehicle-road can give a new point of view on road safety
- Human machine interface can be implemented monitoring physiological data, in order to “automatically” activate safety device and systems.
- The Bioengineering studies can help technology to move from science fiction to the reality.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