



An exceptional species regarding:

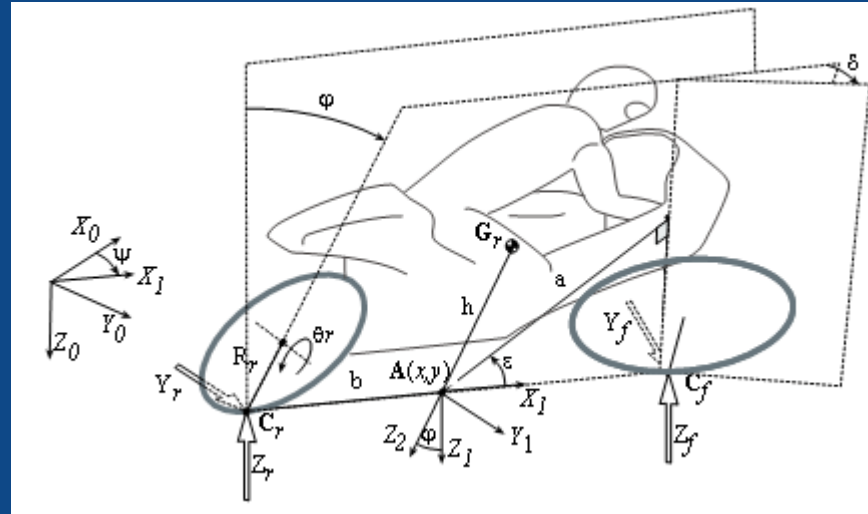
- A. Vehicle Dynamics
- B. Accident scenarios



...this has consequences for advanced safety technology



Vehicle dynamics - a complex topic...



$$Gr = \text{POINT} \left(\begin{array}{l} \text{frame} = \begin{bmatrix} c(\psi) & -s(\psi) c(\phi) & s(\psi) s(\phi) & x \\ s(\psi) & c(\psi) c(\phi) & -c(\psi) s(\phi) & y \\ 0 & s(\phi) & c(\phi) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \text{coords} = \begin{bmatrix} 0 \\ 0 \\ -h \\ 1 \end{bmatrix} \end{array} \right)$$

...let's keep it simple!



Different vehicle dynamics...



Motorcycle

- ,3D' dynamics
- Leaning

- Steer left – turn right
- Steering by ,inertia force'
- Complex behaviour

Car

- ,2D' dynamics
- Not leaning

- Steer left - turn left
- Steering by ,mechanical force'
- Simple behaviour

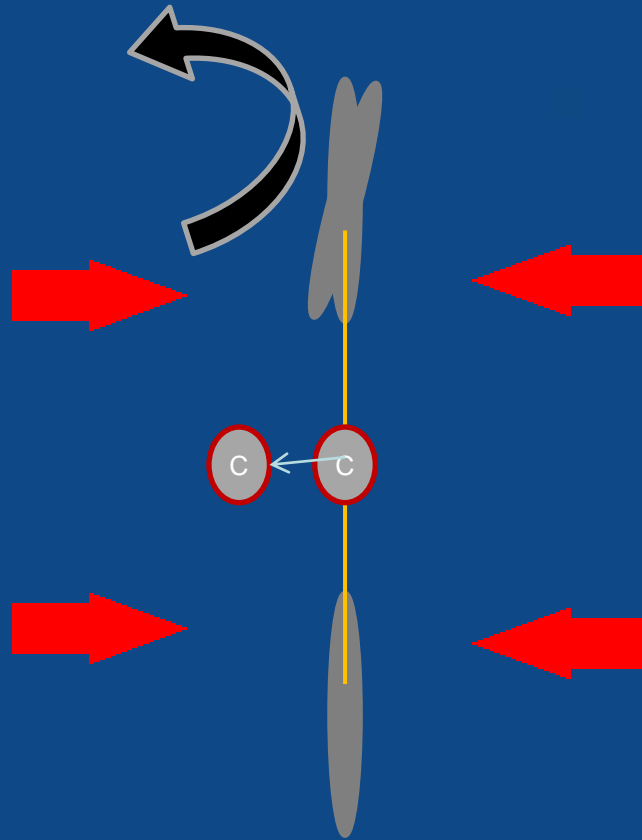
...what it means in real life



Cornering – a matter of balance...



Other forces
Require permanent balance



Not a stable system...

...and rider is part of it

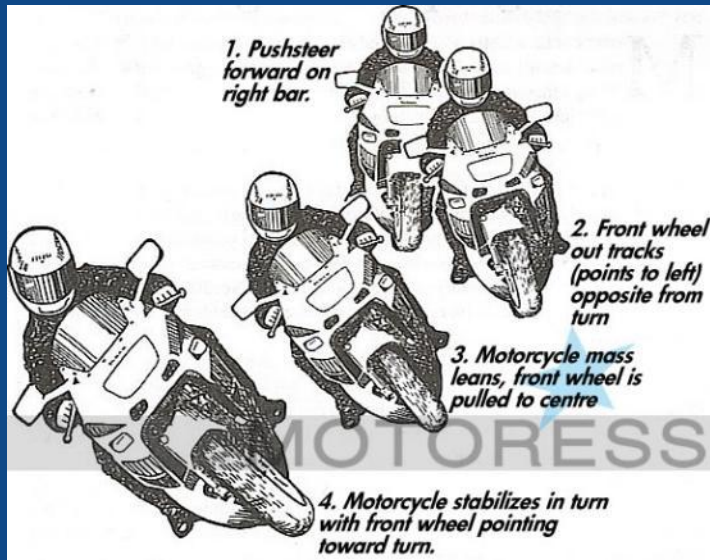
...and only works in harmony of man & machine



THE Human – Machine – System...



Rider is part of vehicle



Driver is operator only



...exposed to further influences



A delicate balance...



Great photo showing example of a pushsteering! Note direction of front tyre to the left as bike is being set up to go right!- MOTORESS

1. Body shift & weight

2. Throttle / speed

3. Center of gravity (rider & bike)

4. Tyre pattern / type

5. Deceleration / braking



...managed by rider's intuition and skill



Technology can't replace skill...



...only help the rider



No easy transfer...



One cannot just take ITS features / assist systems from car to motorcycle

Systems taking control of vehicle must be

- Entirely different
- Or
- Are not possible

...and let's look at crash scenarios



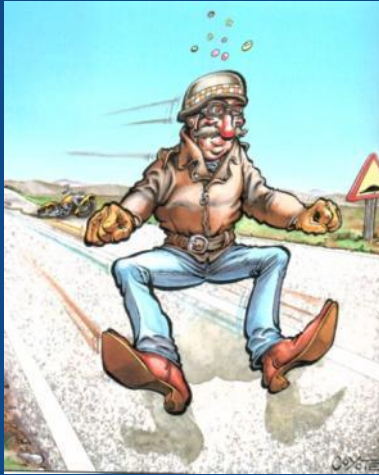
Accident detection is challenging...



...because there is more than only one accident



Accident scenarios are different...



- Bike and rider separates
- Unpredictable trajectory for both rider and bike
- Not known accident scenarios



- Occupants remain inside car
- Trajectory of car predictable
- Known accident scenarios

...and require more depth studies






...with 'chaos' scenario



Reasons for 'chaos' scenario...



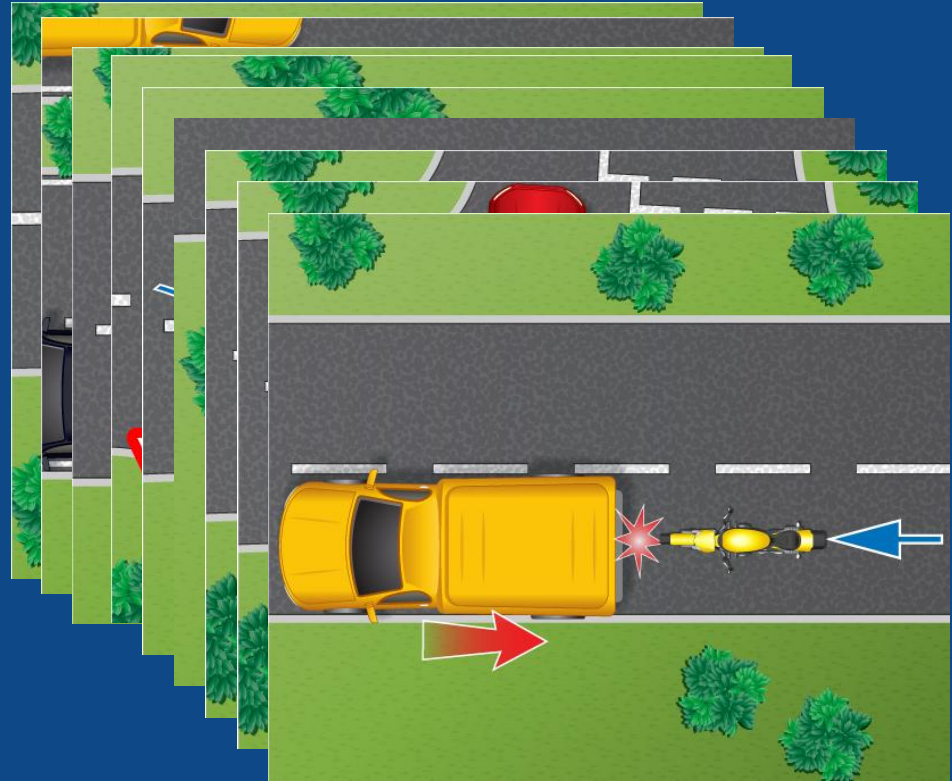
- Vehicle dynamics
- Small frontal area
- Low weight / mass
- Rider / vehicle separate
- Balance
- Deflection
- Deflection
- Two scenarios

- 
- ❖ Injury hardly predicable for rider
 - ❖ Accident recognition and accident prediction extremely challenging
 - ❖ No best practice in the past (i.e. triggering airbags on cars...)
 - ❖ Industry has just started to develop methodologies

...need more study



We know main 'use cases'...



...we need better in depth understanding

