Association mondiale de la Route

AIPCR VIA VITA PIARC

World Road Association

The 12 basic axioms of engineering for safer Roads

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Lome, Togo
October 2006

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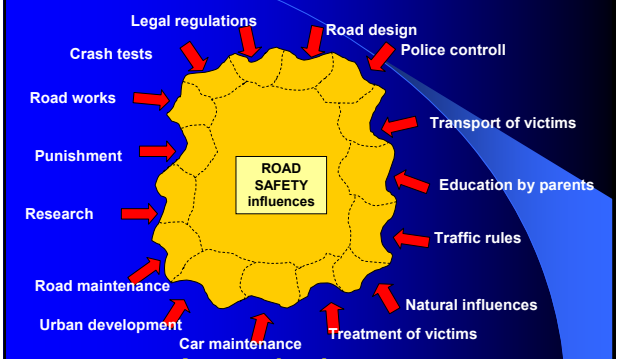
Road Transport Safety



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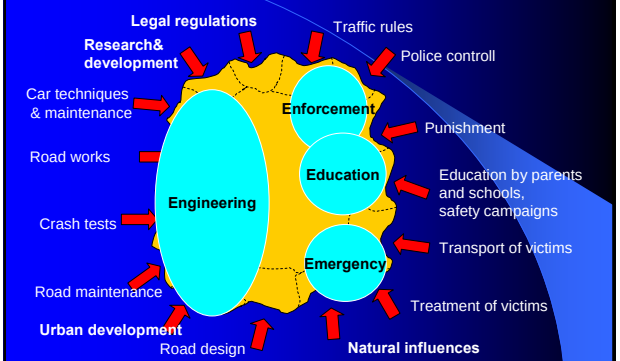
A complex issue

2

The fife „E`s“ of road safety activities



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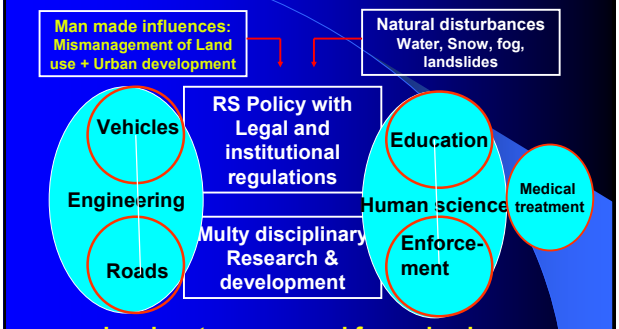
The Road Transport Safety System

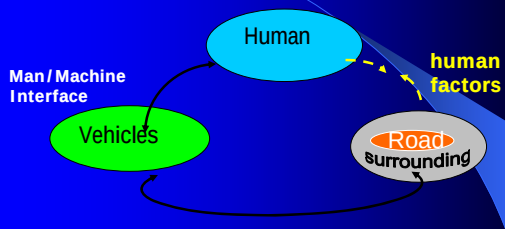


…has has two axes and four wheels.

Local mismanagement of urban development and endless linear settlements may be among …

…the most crucial disturbances for road safety in developing countries

3 elements of the road transport: What are the interfaces?



The physical factors

The Physical factors are:

- ►Function and Network
- ►Geometry
- ►Dynamics
- ►Drainage
- ►Road equipment

An efficient and safe road network is organized like our blood system: It is a hierarchy of Arteries and Veins

- Main arteries
- Distributors
- And arterioles and capillaries to access the single cells in the muscles and organs.

Volume and speed:

The blood moves much faster in the Main Arteries

- main arteries to legs and arm 5.8 cm/s

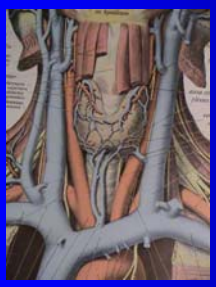
than in the Organs

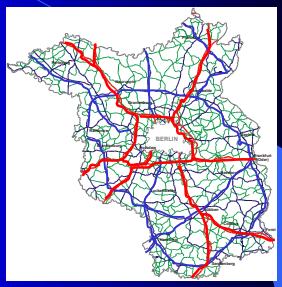
- arterioles 0.28 cm/s
- capillaries 0,05 cm/s

So it is with the road network:

The traffic volume and the speed on our main arteries along far distances has to be higher than in our towns and cities

Axiom 1: The main blood vessels never provide their surrounding tissue directly!





…. And the main roads of the road network don`t

Axiom 2: Avoid mixed functions and respect the needs of none motorized users

- By separation of the fast and far traffic from the slow local traffic and
- By a strict access control

Axiom 3: follow two different design principles:
1. Geometric design for urban roads

- Most important factors are the shape and size of vehicles
- Less important factor is speed because legal speed is 50 km/h and lower
- Application in urban areas, settlements and small rural roads
- Speed enforcement by design (traffic calming)

Axiom 3.2: Dynamic Design for interurban roads

- Most important factor is speed
- Legal speed is higher than 50 km/h
- Application along interurban and express roads
- Decisive dynamical formula is :

$$fr + q = v^2/g*r$$

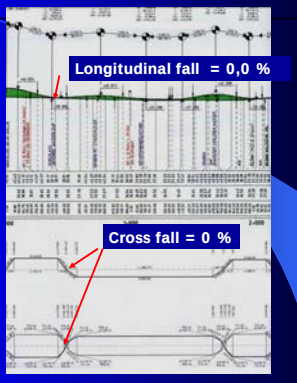
fr = skid resistance
q = cross fall/ super elevation in curves
v = speed, g = gravitation, r = radius

Axiom 4: Provide sufficient Road Drainage! (and prevent other natural disasters)

- **Drainage of the road surface by a cross fall in straights of 1,5 to 2.5% and**
- **A safe design for the drainage system beside the carriageway**

(see axiom 12)

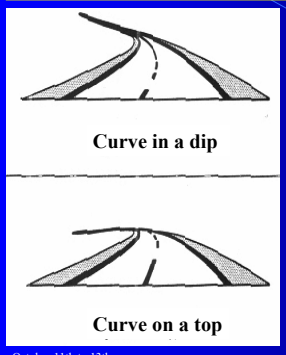
Lack of coordination between horizontal and vertical alignment



Axiom 5: Assist road users perception!

- A 5.1: Avoid optical illusions
- A 5.2: Avoid delayed and restricted perception
- A 5.3:Avoid Figure-Background-Problems
- A 5.4: Use Multiple codes.

A 5.1: Avoid optical illusions!



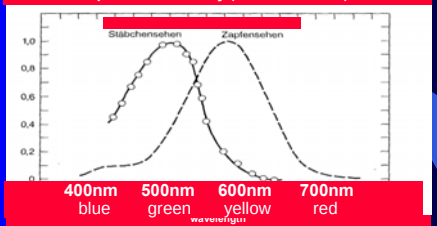
Curve in a dip

Curve on a top

A curve in a dip seems wider than on a hill top. The result is that road users drive faster in the dip than they should

A 5.2: Avoid delayed and restricted perception!

Spectral sensibility (Goldstein 1996)



- The rods and cones of the retina detect green and yellow with a higher sensibility than red and blue

A 5.3: Use that knowledge to avoid Figure-Background-Problems!

Signs to announce the curve are not detectable.

The perception of the signs is improved by a yellow frame .

Birth 2001 / Wartmann 2002

A 5.4: Use multiple codes - faster reaction to combined signals!.

Canada: rumble strips

Rumble stripes in Vietnam

Drivers have different reaction times:

1. Faster reaction to audible 150 ms
   than to visual signals 200 ms

2. Faster reaction to combined than to single visual or audible signals. .

Axiom 6: Give unmistakable orientation for different types, functions and speeds for urban roads,…

Höppner, 2002, Vollpracht 2003

…for interurban roads

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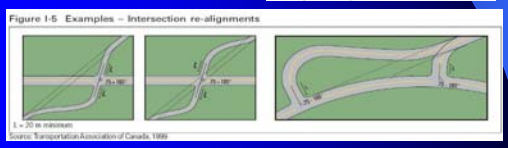
BSVI 2001 / Vollbracht 1999

….and for the right of way at intersections



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Axiom 7: Never misleade the driver!

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But give clear orientation for changes in direction and speed

HVO-Guideline, Birth/Staadt /Sporbeck 2001

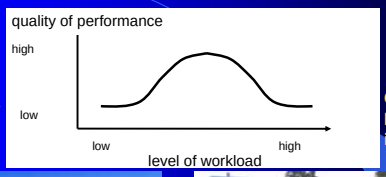
Assist the orientation in curves by superelevation

..and keep the inside (of the curve) free from vegetation

Our ability to decide in a short time is limited.

The more information we need the longer is our reaction time

Axiom 8: Don´t overload Road Users



Hacker 1984

Undercharge by Monotony

Overcharge by information

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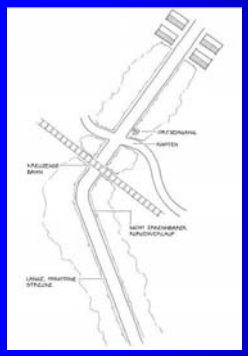
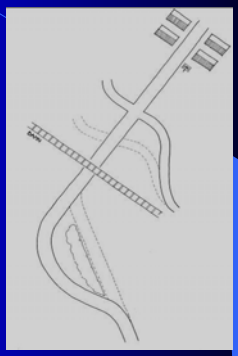
..and reduce the number of events and decisions at one location





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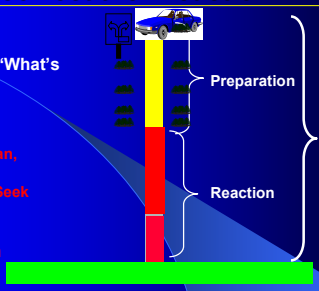
Drivers need time to plan, check + correct their reaction.

Area of perception: "What's going on?"

Area of orientation: Plan, check and approach + correct reaction 4-6 Seek

Braking area: technical slow-down



How long are the distances for Transition?

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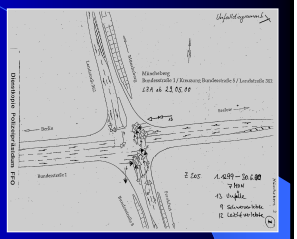
HVO-Guideline, Birth/Staadt/Sporbeck 2001

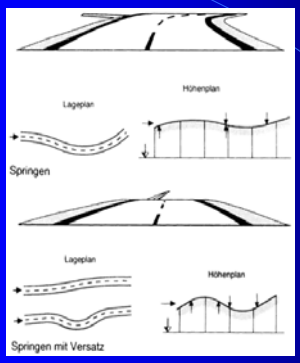
Axiom 9: Never surprise the driver!



Drivers make mistakes if the situation suddenly changes.

Use transitions where ever the situation will change!

A 9: Never surprise the driver!



If the road course is jumping aside it is very surprising

Provide different preparation + reaction distances for different speeds

Speed	100 km/h	80 km/h	60 km/h
2-3 seconds Orientation	56 – 84 m	44 – 66 m	34 – 51 m
2-3 seconds Approaching	56 – 84 m	44 – 66 m	34 – 51 m
Breaking until stop	115 m	65 m	35 m
Total distance for orientation	227- 283 m ~ 300 m	153 – 197 m~ 200 m	103 – 137 m ~ 140 m

Axiom 10: Give enough sight distances for:

- View on the road course for orientation
- Stopping and overtaking
- Visibility at night
- Visibility on dangerous road sections, intersections, pedestrian crossings and so on

Axiom 11: Take into consideration the interrelation between the choice of speed and design features .

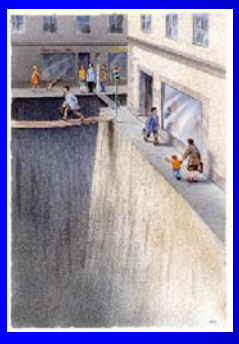
Pay attention to:

- The interrelation between speed and the point of fixation
- The influence of the surrounding, width of the carriageway and so on
- Mistakes by estimation of speed and distance

…and use it for enforcement by road design and for traffic calming

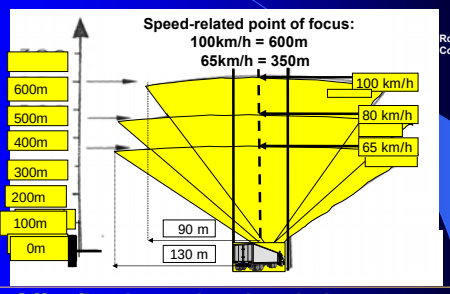
Vollpracht / Birth, 2002

We have not the same feeling for speed than for hight



Source: Swedish Road Administration

A 11: The farther the sight distance the faster the speed



Roth, 1973 in: Cohen, 1984

Offer fixation points in relation to your design speed!

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A 11: Avoid differences between the legal speed and the design speed

- Motorways: ≥ 120 km/h
- Express roads: = 100 km/h
- Main distributor roads,
- and Highways: = 80 km/h
- regional distributor roads: = 80 km/h
- Community connections: = 60 km/h
- Roads in cities and villages: ≤ 50 km/h

Axiom 12: Give an error forgiving road side!

- It is possible to adapt the road transport system to the physics of the vehicles and the nature of the users. But human errors are not totally avoidable
- We need an error forgiving road side

- Roadside obstacles and steep slopes don't!

Road side obstacles are of a different nature



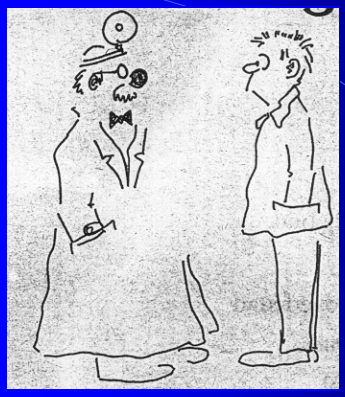

…and mostly man made

They should be totaly avoided or…

Example of smooth roadside area design in earth cut (from Sweden)

Example of energy absorbing barrier (from Germany)

…well protected by barriers



Thank you for your patience