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HF Guiding Principles in Road Design: Spatial perception of the driver

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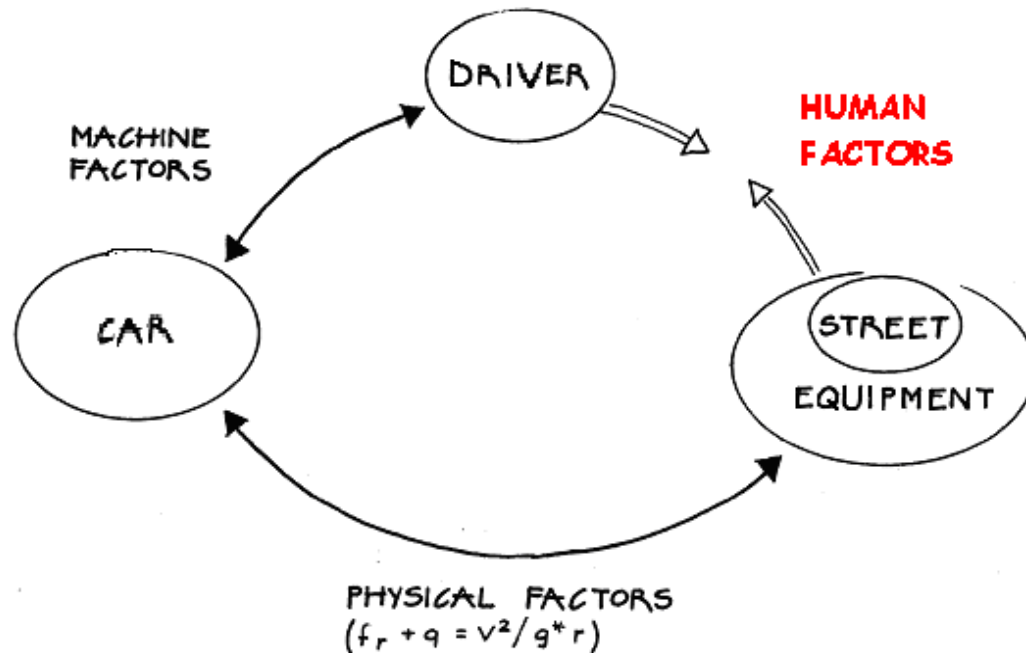
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Human Factors = contribution to damaging events

- Psychological / physiological limits of space perception, space movement information processing, decision making, act regulation

Main Aim: Identification of accident triggers by misleading optical road features



Results of HF Audit of 10 international design standards

Yes: HF requirement is fully integrated in the standard

Partly: HF requirement is partially integrated but it is not mentioned that it is a HF need

NO: no such term/requirement is mentioned in the standard

TC1.1 HF-Subgroup
audited 10 international
design standards

Question:
**Are Human Factors
principles of space
perception integrated?**

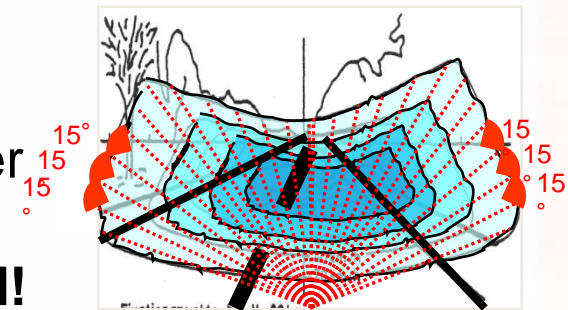
	YES (Number of country's)	PARTLY (Number of country's)	NO (Number of country's)
I. 6 Second Rule - Give enough time!	5	3	2
II. Field of View - reliable orientation + guidance!	1	3	6
III. Logic Rule - consistent design and signing!	3	2	5
Fulfilled out of 10 HF-Demands	30%	25%	45%



Main Human Factors of Road Users:

Psychological Stereotypes of Space Perception

- Left-hand phenomenon: movement in the space counter clockwise to the starting point
→ **Right hand curves are more difficult!**
- Dynamical Perception of space, depending on
 - changing position + changing view axis
 - changing reference points / lines→ **Orientation/Balance is naturally unstable!**
- Eyes search motion: 15° interior circles counter clockwise, after 8m ends 3D-perception
→ **The further the focus, the faster the speed!**



Space perception + movement is predominantly subconscious.



6-Second Rule: Don't surprise the driver!

Minimal adapting time = 4-6 sec. (100m-300m)

driving action:

section of road:

braking

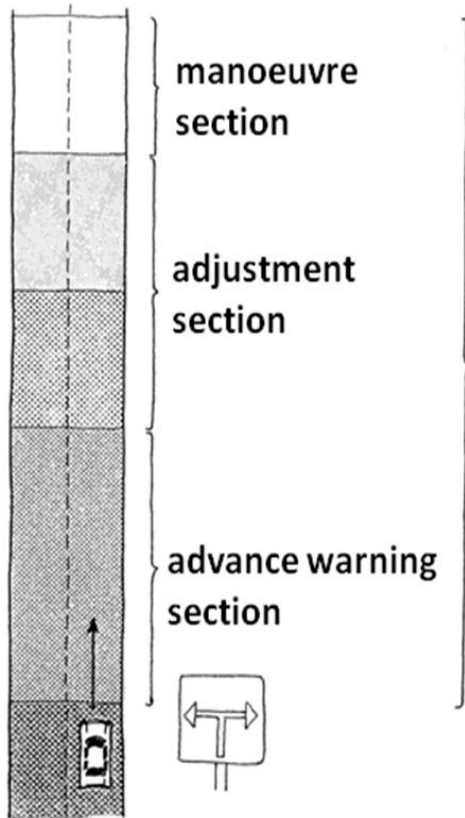
technical braking
time, x sec

decision

planning, testing,
correction 2-3sec

orientation

What's the
matter? 2-3sec



6-Second Rule: driver has to see critical points to break early enough

6-Seconds Rule: Don't surprise the driver!										
	NL	Por-tugal	Ca-nada	Ger-many	France	Aus-tralia	Japan	Hun-gary	Czech Rep.	China
Transition zone	Y	Y	Y	P	Y	Y	Y	P	No	No
Perception and Visibility	Y	P	P	P	Y	Y	No	P	Y	No

Conclusion:

- The 6-Second-Rule is considered in most of the 10 standards.

To be included:

- Ensure unobstructed visibility of critical points (planting, ongoing curves, building or traffic facilities)



6-Second Rule: no transition and visibility of railway crossing

invisible railway crossing
50m ahead



Examples from Czech. Republic

announced railway crossing
150m ahead



6-Second Rule: no transition and visibility of pedestrian crossings

invisible pedestrian crossing
50m ahead



Examples from Germany and Czech. Republic

visible pedestrian crossing
30m ahead



6-Second Rule: good practise examples from other countries

additional signing of intersection with poor visibility



visible pedestrian crossing 50m ahead



Examples from Czech. Republic and South Sweden



Field of View: The Road has to offer a safe Field of View!

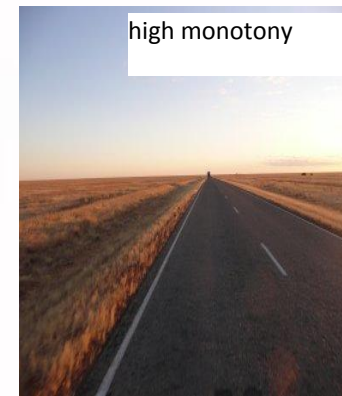
Field of View Rule: Give reliable orientation and guidance										
	NL	Por-tugal	Ca-nada	Ger-many	France	Aus-tralia	Japan	Hun-gary	Czech Rep.	China
Optical density of the field of view	P	P	No	No	P	P	No	P	P	No
Fixation objects support optimal lane tracking	No	P	No	No	No	No	No	No	No	No
Depth of field of view	Y	P	No	Y	P	No	No	No	No	No

Conclusion:

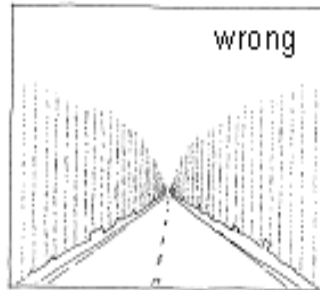
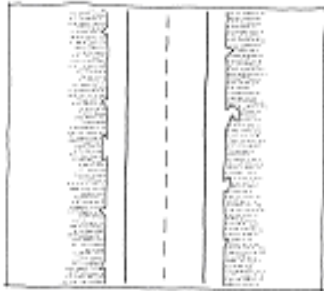
- The Field of View Rule is not considered in most of the 10 standards.

To be included:

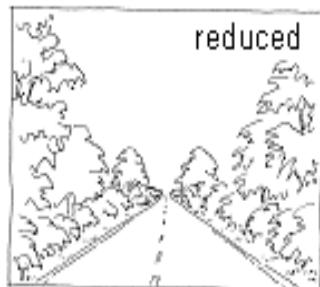
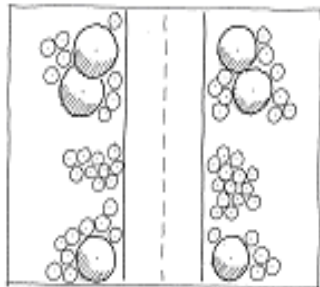
- This Human Factor principle should be integrated directly in the standards.



Field of View: Monotony causes high speed



monotonous field of view
→ higher speed



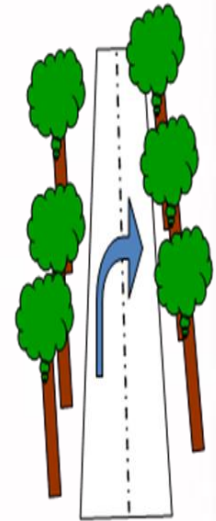
contrasts of colours and forms
→ lower speed



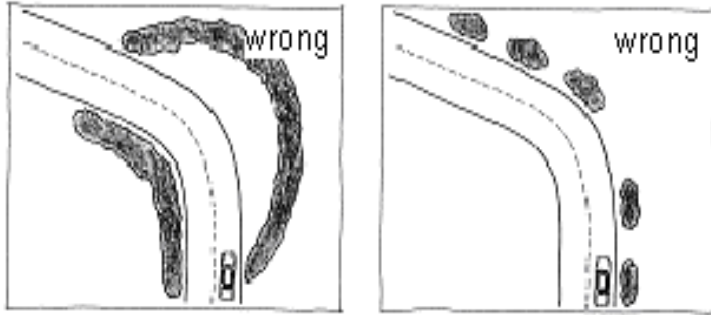
Field of View: non orthogonal appearance causes subconscious lane change / running out of lane

The suspension disturbs the balance → users totter to the right

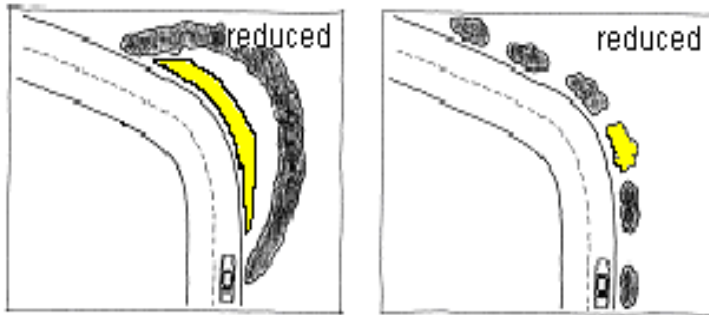
Destabilisation by non-orthogonal impression → head-on collisions



Field of View: wrong framing of curves



misleading frame (left) or **gaps** (right)
in the outer curve



parallel frame (left) + **closed gap** (right)
in the outer curve



Field of View: wrong framing of curves

Bad practice → gap in the outer curve



Bad practice Canada → abutment is not symmetrical to the road's axis



Logic Rule: The Road has to manage driver's expectations!

Logic Rule: Offer consistent design and signing										
	NL	Por-tugal	Ca-nada	Ger-many	France	Aus-tralia	Japan	Hun-gary	Czech Rep.	China
Town entrance (Change of function but no change in design + optical characteristic)	Y	P	No	No	Y	No	No	P	P	No
City by-pass dilemma (Change of direction despite dominant eye-catching orientation line)	P	No	No	No	P	No	No	P	No	No
Effect of preprogrammed habits and routines	Y	Y	Y	P	P	No	P	No	No	No
Multiple critical points occur concurrently	Y	Y	Y	No	Y	No	No	No	No	No
Deficiencies in traffic control devices	Y	Y	Y	P	Y	Y	Y	P	Y	No

Conclusion:

- The is only partly considered in most of the 10 standards.

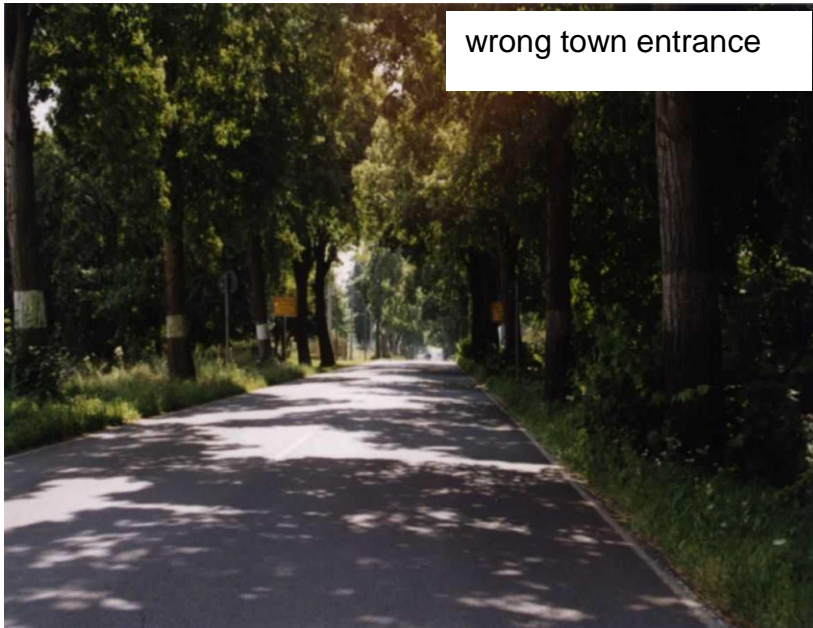
To be included:

- Most parts of this Human Factor principle should be integrated directly in the standards.



Logic Rule: If road changes function – change optical appearance too!

Town entrance **without change**
in optical appearance



Town entrance **with good change**
in optical appearance



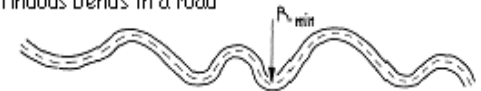
Logic Rule:

Roads have to follow Driver's Perception Logic

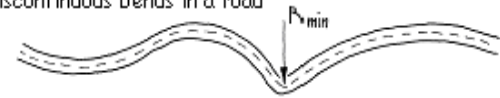
Discontinuous curves in a road causes accidents!

Elimination of accident points
by continuous expansion of road curves

continuous bends in a road



discontinuous bends in a road



———— Existing road section+accident focal point
xxxxx

----- **Variant 1:** too-generous upgrading
(shift of accident focal points)
oooo

----- **Variant 2:** continuous expansion of winding road
(Elimination of accident focal points)



Logic Rule: If road changes direction, avoid wrong capturing viewing direction

Roads direction: to the right
Viewing direction: straight



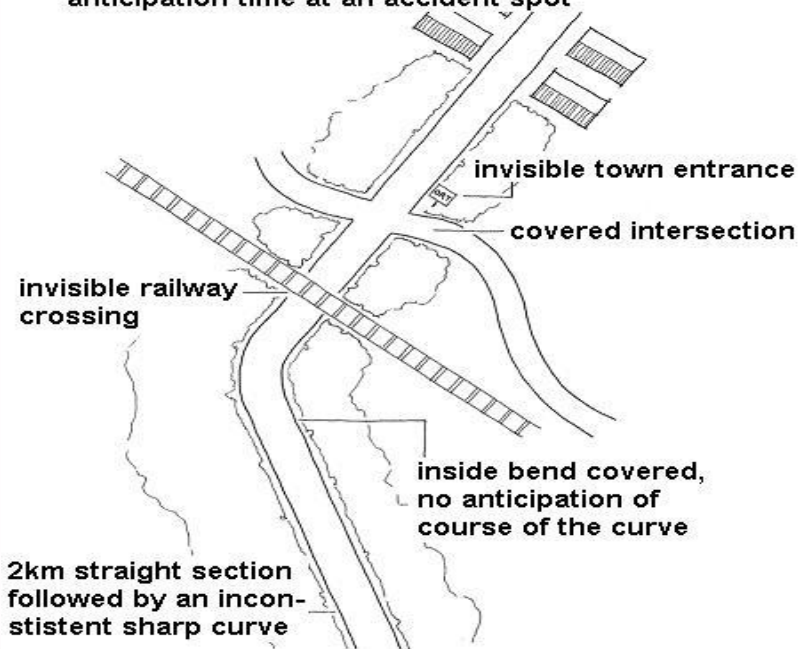
Roads direction: to the right
Viewing direction: guided to the right



Logic Rule: Inform the Driver progressively of multiple critical points!

Multiple critical Points are
not visible / announced

Accumulation of critical points without sufficient anticipation time at an accident spot



Good visibility of multiple critical points



Conclusion

- In summary 30% of Human Factor demands are already described and integrated in the standards and 70% only partly (25%) or not at all (45%).
- Especially the management of the field of view and of driver's expectations should be clearly integrated in design standards and in RSI and RSA.
- It is now up to the responsible government road authorities to use these results to prevent accidents, save human life and ensure that state-of-the-art science and technology is used to achieve that goal.

